COFFEE CULTIVATION GUIDE
FOR
SOUTH - WEST MONSOON AREA GROWERS IN INDIA
(COFFEE KAIPIDI)

English Version of "mungaru male pradeshada coffee belegararige coffee kaipidi")-2008

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Foreword

Central coffee Research Institute and Extension wing of Coffee Board have brought out many publications covering the various technological aspects of coffee cultivation for use by coffee growers. In order to maintain the coffee estates in good condition and to increase the production and productivity, it is very important to follow and adopt the improved technologies like use of improved high yielding plant varieties, soil conservation and fertility maintenance, efficient use of agrochemicals and fertilizers, plant training, irrigation, shade management, post harvest processing, integrated pest and disease management practices. Coffee being a perennial crop, it is necessary that the plants have to be taken care off in a timely manner by attending all the cultural and maintenance operations. The production and productivity of coffee in India has registered phenomenal growth over the years, but there is still a wide gap between the potential and the actual. Concerted effort of growers and Research/Extension workers is the need of the hour especially during the regime of changing environmental conditions to narrow down this gap so that improved production and productivity could be achieved at lower input costs. Research and Extension wings of the Coffee Board have played important role in transferring the improved coffee cultivation techniques to the growers. Keeping in view the actual needs of the growers, this coffee cultivation guide book has been brought out for the use of coffee growers in the South-West monsoon areas which details the latest technologies and their uses. I wish that this hand book will be of immense help to growers. I congratulate all the Research and Extension officers who have put in very valuable efforts in bringing out this hand book.

For The growers of South-west Monsoon Area

(ARABICA)

CULTURAL OPERATIONS TO BE CARRIED OUT DURING DECEMBER-JANUARY MONTHS

1. **Nursery**
2. **Arabica coffee harvesting**
3. **Coffee Processing**
   - **(a) : Preparation of Parchment coffee**
   - **(b) : Preparation of Cherry coffee**
4. **Coffee effluent management**
5. **Coffee Berry Borer Management**
6. **Dadap protection**
7. **Weeding**
8. **Watering of young coffee plants**
9. **Soil testing and liming of soils**

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1.Nursery

A gentle sloping land without big shade trees is preferred for raising nurseries. Water should not stagnate in the nursery sites. Stagnant water near the nursery beds cause rotting of seedlings. Suitable water resource should be available near the nursery for timely watering of the nursery beds and seedlings. Any shade trees near the nursery will damage the young nursery seedlings in the beds and poly bags due to water dripping from them.

For sowing the coffee seeds, germination beds of 1 metre width and of convenient length raised to a height of 15 cm from the ground level should be prepared. About 4 bags (10Kgs) of matured farm yard manure or compost well dried under sun light be mixed with 2 Kgs of fine Agricultural lime and 0.5 Kgs of Rock Phosphate and thoroughly incorporated in the nursery beds measuring 1X6 metres. In the nursery high clay content should not be used as they restrict the air circulation causing damage to the sprouting seeds. If one is using the clayish soil, then it should be mixed with coarse sand properly to enable easy air circulation. Any deficit air circulation in the nursery soil will cause stunted unhealthy development of the seedlings sometimes resulting in death of the seedlings. The nursery sites should be totally free from nematodes. Therefore, it is advised and recommended that before preparing the nursery, the soils of the nursery site as well as the soils to be used to prepare the nursery beds should be tested in the laboratories for the presence of nematodes. One should note that the compost/farm yard manure used in the nursery should be free from cockchafer pests.

Selected and certified seeds can be sown during December or January in the nursery beds. The seeds be sown with their flat side facing the soil which helps early germination and easy rooting in the soil. After sowing, the seeds are covered with a thin layer of finely sieved soil and mulched with a layer of paddy straw which ensures optimum temperature for seed germination and protects the seeds from desiccation. If

paddy straw is not available, any kind of other grass materials can be used for mulching. The beds are then daily optimally watered in the morning hours with rose cans. The seeds will germinate in about 40-45 days and attain button or topee stage. Once this stage is reached the mulch covering the beds should be carefully removed without damaging the germinated seeds. The seedlings at topee or button stage can be then transplanted into either into poly bags or in the secondary nursery beds as the need may be.

GROWN UP BEARING ARABICA COFFEE PLANTS

2. Arabica coffee harvesting

In order to maintain and protect the coffee beverage quality, aroma, thickness of the brew, taste and flavour as well as acidity in the cup, the right kind of coffee fruits have to be harvested in right time following certain suggested guidelines. Improper harvesting will result in spoiling the cup quality even if the coffee plants are known to belong to top quality category. Therefore, following the right kind of harvesting procedure will help in protecting the inherent quality as well as helps in getting premium prices.

Coffee fruits have to be picked as and when they become ripe; this can be understood by gently squeezing the fruit with fingers. On gentle squeeze, the bean inside the fruit pops out easily. Under ripe or over ripe fruits should not be mixed or used for the

preparation of parchment coffee as they can spoil the overall cup quality. The under ripe coffee fruits result in the production of immature beans and the over ripe ones cause foxy coffee resulting in brown beans with fruity cup. If the harvest is not possible as and when fruits rightly mature, the under ripe and over ripe fruits needs to be separated from the lot and only right kind of desired fruits have to be pulped in the course of preparation of parchment coffee.

The under and over ripe fruits can be converted into cherry coffee. While harvesting the coffee, picking mats should be used, this helps in easy collection of fallen fruits and prevents the mould formation. Prevention of mould formation avoids the production of Ochra Toxin-A in coffee beans. Use of picking mats also reduces the Coffee Berry Borer infection. One should note that, clean gunny bags or plastic bags should be used for collecting the fruits during harvesting. These bags have to be regularly washed with clean water, dried and used for collecting the fruits. Bags used for storing chemicals, fertilizers, pesticides, insecticides and fungicides should never be used for harvesting coffee fruits. No fruits should be allowed to remain in the plants after the end of season harvest as it can invite berry borer infestation.

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ARABICA COFFEE HARVESTING

3. Coffee Processing

(a): Preparation of Parchment coffee

Parchment coffee or plantation coffee can be prepared by pulping, cleanly washed with water and dried under sun. Preparation of such coffee requires pulping equipments and adequate supply of clean water. The quality of parchment coffee is always superior to that of cherry coffee (whole fruit dried under sun). Cherry coffees always give fruity taste as the beans are in contact with the mucilage for a longer time

during the course of drying period. Therefore, wet processing of coffee is essential to get superior quality coffee and the method can be followed wherever, all the adequate facilities like sufficient clean water and good processing machineries are available.

The pulper, pulper tanks, siphon tanks, rakers, washer, fermentation tanks should be thoroughly cleaned before the pulping operation is undertaken. The premises of the pulper unit as well as the drying yards should be kept in hygienic way. The pulper unit should be properly adjusted depending on the fruit size and checked every day to prevent cuts. Pulper nipped and other deformed beans will yield defective low quality parchment.

The pulping and washing machineries and other equipments used in the preparation of parchment coffee should be cleaned on daily basis. No fruits, fruit skins or beans from the previous day's harvest should be allowed to remain and mix with fresh coffee fruits or pulped beans. These materials badly damage the parchment coffee quality. Only clean water shall be used for processing coffee fruits and all the extraneous matters such as leaves, twigs and stones should be thoroughly removed from the fruits before pulping. If adequate supply of water is not available, then the water used for pulping the fruits can be recycled to pulp the fruits second time. The pulped water however, should not be used on the second day. Further, pulped water should never be used for washing the coffee beans under any circumstances.

As far as possible, harvested fruits have to be pulped on the same day of the harvest. If, it is not possible to process all the fruits on the same day, such fruits can be stored under clean water and pulped on the second day. The fruits stored for more than 10 hours in the open heap without pulping will result in fruity cup. The fruit skins separated by pulping should be taken away from the pulping site as quickly as possible so that microbial decomposition of the skin does not affect the quality of parchment coffee.

SORTING OF RIPE FRUITS

The sticky mucilage on the pulped beans can be removed by 4 different methods. However, the commonly followed/adopted methods are two namely: (1) Natural Fermentation and (ii) : Aqua machine wash by friction.

Superior quality coffee can be obtained by natural fermentation method. Fermentation is a critical stage in processing and has a deep influence on the quality of coffee. When pulped coffee is stored in fermentation tanks along with the mucilage, natural hydrolysis of pectins present in coffee mucilage occurs due to the enzymes naturally present in coffee mucilage. In Arabica coffee, natural fermentation will be complete

in about 24 to 36 hours. However, this may take longer time also when the ambient temperature is too low. The fermentation process should be controlled so that over fermentation is avoided. Over fermentation will result in foxy beans and make the coffee cup sourish. The under fermented coffee results in imparting mustiness in the cup. The correctness of fermentation can be checked by rubbing the fermenting beans with hand. The mucilage will come off easily and the parchment does not stick to the hand after wash. The beans feel rough and gritty when squeezed by hand and a feeling similar to squeezing pebbles is felt. After the correct fermentation, the beans are cleanly washed 3 to 4 times in clean water or in a washing machine. The quality of the coffee can be further enhanced, if the washed beans are soaked under water for about 4 to 6 hours.

The parchment coffee prepared in such method initially contains around 50 – 55% water content in them. The superficial water content should be removed by spreading the parchment over wire mesh trays and then dried on clean cement or clay lined drying yards till the moisture content reaches a value of 11.0%. Generally parchment takes about 7 – 10 days for drying when spread at a thickness of 4 – 7 cm. If the parchment is spread too thin, rapid drying of coffee at this stage causes the parchment skin to split which lead to cracking of parchment, shrunken and boat shaped beans. Stirring and turning of parchment coffee at least once an hour is essential to facilitate uniform drying. The parchment should be heaped during the evening time and covered with polyethylene/tarpaulin sheets/gunny bags. Drying mass of parchment coffee should never be exposed to mist. Parchment coffee should not be exposed to the hottest sun between noon and early part of the afternoon especially on the 3rd and 4th day of drying. Exposing the parchment to the hottest sun during the 3rd and 4th day will result in wrinkled beans. Once the coffee is dried to a recommended moisture level of 11.0%, the coffee has to be bagged in clean and dry gunny bags. Coffee of different lots should be bagged separately. New gunny bags should be always turned inside out well aerated before use as otherwise the coffee will absorb natural oils and off odours from the bag and give rise to an “acrid” (bitter/pungent/harsh) cup. If the gunny bags are procured from curing works, the bags should be properly fumigated or the curing works should be asked to fumigate and supply to avoid the spread of Coffee berry Borer infestation. Coffee should be stored in well ventilated and dry store rooms. The coffee should be stored on raised wooden platforms to ensure proper circulation of air underneath the bags. Parchment coffee and cherry coffees should not be stored one over the other. The fertilizers, chemicals, oils, insecticides and pesticides should not be stored in the coffee godown.

DRYING PARCHMENT COFFEE

(b): Preparation of Cherry coffee

To prepare cherry coffee, fruits should be picked as and when they are ripe. Greens and under ripe fruits should be sorted out and dried separately. All the extraneous matters like twigs and leaves should be separated from the fruits and dried. The fruits should be spread uniformly in the drying yards at a thickness of 7 – 8 cm. Clean cement or clay lined drying yards should be used for drying the cherry coffee. Use of cow dung smeared or mud drying yards should be avoided. Drying coffee in such yards causes mould formation in cherry coffee and quality of such coffees is very inferior. Coffee should be stirred and ridged at least once every hour to facilitate uniform drying. In the evening time cherry coffee should be heaped and covered with polythene or tarpaulin sheets to avoid contact with the mist. The coffee will be fully dry in about 10 -12 days under the bright weather conditions. Cherry coffee should be dried to a moisture level of 12 to 12.5%. The cherry is dry when handful of the drying cherry produces rattling sound when shaken and a sample forlit records the same weight on two consecutive days. At the end of the harvest, the remaining fruits on the plants should be completely stripped and fallen fruits should be gleaned cleanly. If this method of complete stripping and gleaning is not followed, there is a danger of Coffee Berry borer infestation during the coming years. Stripped and gleaned coffee should be dried separately and should not be mixed with other coffee.

4. Coffee effluent management

Letting out of untreated coffee effluent to natural water streams or to open lands is environmentally unsafe as it causes water and land pollution. Use of untreated coffee effluent for irrigation is also prohibited by the law. Since, coffee processing coincides with the dry season when amount of water present in the natural streams is at the minimum, causing further concern of higher degree of pollution.

The coffee effluents emanating from the pulper units are highly acidic and contains high amounts of dissolved and suspended biodegradable organic matters. These effluents, if discharged into natural water bodies without treatment, pollute the receiving bodies by depleting dissolved oxygen present in it. Polluting natural water bodies will have an adverse effect on domestic users, aquatic life, livestock and water course down the stream. The pollution load of coffee effluent is measured in terms of Biological Oxygen Demand (BOD) and Chemical Oxygen demand (COD). Depending on the quantity of water used to process one unit of clean coffee (1 M.T), the BOD and COD amounts vary in the effluent. The amount of BOD range between 8000 and 13,000 ppm and the COD levels will be around two times of the BOD present in the effluent. One should note that BOD levels will increase if pulped water is recycled during the processing.

In order to protect the environmental health and to control the pollution on account of polluted water reaching the natural water bodies, agricultural land and open spaces, Central Pollution Control Board (CPCB), Government of India has imposed certain laws and guidelines for handling effluents. These guidelines have to be followed mandatorily failing which the person is severely punishable under the law. As per the CPCB statute, the water to be used for irrigation should not contain more than 100 ppm of BOD and water to be discharged to natural water bodies should not contain more than 30 ppm of BOD. Since, coffee effluent contains more than the stipulated levels of BOD and COD, it has to be treated by following recommended methods of treatment before use in the field or discharging it to the streams.

Steps to be followed in the treatment of Coffee Effluent

- All the fruit skin shall be cleanly separated from the pulped water using suitable screens
- The coffee effluent coming out of the washer unit should be stored in a lagoon for one day. The capacity of this lagoon shall be of one day's water use capacity of the processing unit.
- This effluent should be neutralized with appropriate amount of Agricultural lime so that the pH of the effluent is around 6.9 to 7.0. Generally 5 grams of good liming material is adequate to neutralize 0ne litre of the effluent.
- After one day of storage, the effluent is allowed to the anaerobic lagoon. Before allowing the effluent to the lagoon, the anaerobic lagoon should be charged with 4% cow dung slurry up to 10% of the capacity of the lagoon. Charging of the anaerobic lagoon should be done one month before the pulping operation starts so that the methogenic bacteria present in the cow dung slurry which are responsible for the degradation of the biological materials get stabilized. The capacity of the anaerobic lagoon should be equivalent to 21 days effluent production with a maximum depth of 3 metres.
- Add 4.5 kg of urea and 2.5 kg of super phosphate per every 20000 litres of effluent.
- After 21 days, the effluent from anaerobic tank should be allowed to the aerobic tank. The depth of this lagoon should not be more than one metre and capacity should be of 7 days effluent production
- In aerobic lagoon, addition of 450 g of urea and 250 g of super phosphate per 20,000 litres of effluent is essential.
- The effluent coming out of the aerobic lagoon be then stabilized in another tank for one day and used for irrigation if the BOD level is around 100 ppm.

Preparation of cherry coffee is one of the ways of avoiding water pollution. The cherry coffee prepared from mature fruits which are carefully picked and sorted has better quality. Preparations of pulped natural coffee (as in Brazil) also contribute towards avoiding the production of coffee effluent.

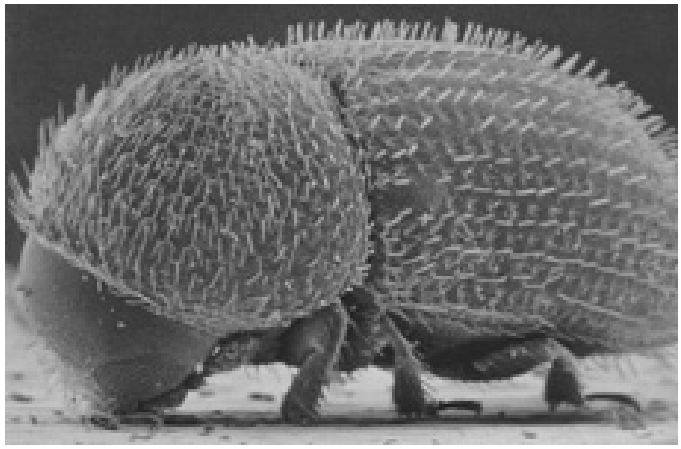
PLASTIC SHEET LINED LAGOONS

BIO-REACTOR TO TREAT COFFEE EFFLUENT

5. Coffee Berry Borer Management

All the recommended phyto sanitary methods have to be cleanly followed in the estate adopting cultural and mechanical operations.

- Broca traps have to be installed in the estate as well as near the drying yards
- Picking mats should be used during the harvesting. Use of picking mats facilitates the easy collection of fallen berries and avoids the berries coming into contact with the soils thereby preventing the possible mould formation.
- All the left over berries on the plants and gleanings should be cleanly picked
- If the berries are partially damaged by Coffee Berry Borer, such berries can be immersed in boiling water for 1 minute and then dried.
- Highly damaged berries should be destroyed by burning
- Coffee should be dried to the recommended moisture level.
- Care should be taken not to transport coffee from the CBB infested area to the non-infested areas.
- While procuring gunny bags from the coffee curing works, they should be properly fumigated to avoid the entry of CBB into your estate. The growers shall demand fumigation of gunny bags by the coffee curers. Always use clean and as far as possible new gunny bags.



COFFEE BERRY BORER

6. Dadap protection

Protect the young dadap plants (during the first 2 years after planting) from scorching sun by treating (brushing or spraying) the stems with 10% lime solution (10.0 Kgs of spray lime in 100 litres of water).

7. Weeding

If the weeding is not done during October/November months, then weeding operation should be undertaken during December month using slash weeding. Generally during these months, weed growth is very poor due to lack of moisture in the soil. Avoid use of herbicides and weedicides or use them judiciously. This will help in maintaining the soil and environmental health from hazardous chemicals.

8. Watering of young coffee plants

After the cessation of monsoon, it is recommended that young coffee plants should be irrigated with 5 to 10 litres water per plant once in a week. This avoids the wilting and death of young plants and facilitates easy and faster rooting of the plants. The growth of watered plants will be better and plants grow healthily. When the moisture content of the soil comes down in watered plants area, again the plants need to be watered so that wilting of the plants can be prevented. It should be noted that weed germination is faster in the watered region and regularly they should be slash weeded. Water requirement is generally higher (evaporation rate is more) wherever, shade density is low and in such places mulching of young plants is necessary.

9. Soil testing and liming of soils

Liming of Soils

In order to grow healthy coffee plants and to realize better crop, it is very important to protect primarily the soil health. The various plant nutrients in the soil need to be maintained in balance so that the soils remain productive for a long time. The acidity (pH) determines the productivity of the soil and nutrient assimilation/mineralization in the soil. In order to have better fertilize use efficiency of the applied fertilizers, the soil pH should be maintained at around 6.1 in coffee soils. Due to the continuous application of acid causing fertilizers like ammonium sulphate, ammonium chloride and DAP and due to the leaching of calcium and magnesium elements in the soil, the soils tend to become acidic. Therefore, to monitor the soil pH, soils have to be tested compulsorily once in 2-3 years. When the soil pH

goes above 6.2 or comes below 6.1, the soil pH needs to be corrected because the availability of essential plant nutrients depends on the soil pH. Strongly acidic soils (pH below 4.5) are relatively poor in productivity because of essential plant nutrient deficiencies or toxicities of essential or non essential elements. Highly acidic soils are harmful for the useful soil micro-organism and in such soils coffee plant growth is always tend to be stunted in nature. If the soils are alkaline (above pH 7.0), most of the essential plant nutrients are not available to the plants.

Whenever, the coffee soil pH falls below 6.1, the soil pH should be corrected by the application of alkali forming soil amendments like agricultural lime(Calcium Carbonate), dolomite (Calcium and Magnesium Carbonates). Liming of the coffee soils can be done anytime of the year except during monsoon period. However, keeping in mind the coffee zones, it is known that November to February months are the ideal period for lime application. One should take care that adequate moisture is present in the soil for the best use of applied lime. Liming materials has to be uniformly broadcasted in the field. Finer the liming material, higher will be its efficiency and the soil pH gets corrected faster. Liming of the soil should be done only after soil test and the quantity of the liming material accordingly decided.

If the recommended dose of liming material is more than 3.5 metric tonnes per hectare, in such case the dose has to be split into two equal parts and applied in 2 years. The scientific use of lime on acid soils can appreciably improve the soil productivity and the plant uptake of nitrogen, phosphorus, potassium and micro nutrients. In the case of soil pH going beyond 6.2, then pH can be corrected by the application of acid forming fertilizers. It is recommended that each lime samples should be tested for purity before use in the field. This will help in deciding the correct quantity of the procured lime to be applied in the field based on its purity.

Soil Sampling

It is important that the soil samples collected should be the representative of the field to be tested. The important procedure to be followed for the best sample collection is as follows.

- The field has to be divided into blocks of 2 hectares each. Sample each block separately.
- When the areas within the field differ distinctly in growth of plants or appearance of the soils or known to have been treated differently, soil samples in such blocks should be collected and labelled separately.
- Do not collect the sample during rainy season. Do not send the soil samples for analysis which are collected long back and stored.
- Select at random 20 spots in each block, remove surface litter and dig a hole of 9 inches diameter using a suitable tool up to 9 inches depth. Scratch the soil samples uniformly round the hole from top to bottom and collect 1 kg of the sample and mix well to get the composite sample..
- Samples should not be collected from the blocks which are recently limed or fertilized. Do not collect samples from road side, old bunds, and marshy places or near the shade trees. Collect soil samples at the centre of 4 coffee plants.
- Dry the samples under shade and pack in a polyethylene bags or cotton bags and send to the laboratory properly labelled. Do not use fertilizer contaminated bags.

- Give the details of the estate, crop harvested for the last 5 years, elevation, rainfall details, irrigation schedules if any, variety of coffee and age of the bushes.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING FEBRUARY-MARCH MONTHS

1. **Fire path**
2. **Stripping of the crop**
3. **Gleaning**
4. **Leaf analysis**
5. **Pre-blossom Bordeaux Mixture Spray**
6. **White Stem Borer Management**
7. **Compost preparation**
8. **Pruning**
9. **Basket nursery**

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1. Fire path

During the summer period there is a chance of wild forest fire occurring in the nearby forest or in the vicinity of the coffee estate. Hence as a precaution, fire paths have to be created round the estate by clearing all the dried leaves, dead tree remains, branches etc in order to avoid the fire spreading to the estate.

2. Stripping of the crop

At the end of harvest, the berries remaining on the coffee plants have to be stripped off completely. This operation should be done carefully without harming or damaging the plant branches or new flower bud bearing branches. If the new shoots and branches are damaged, it will affect the next year crop. The one of the advantages of complete harvest is to reduce and avoid berry borer infestation during the coming years. Stripped berries should be dried separately and should not be mixed with other coffee as the quality of such coffee is inferior.

3. Gleaning

During the harvest some amounts of berries fall on the ground. At the end of complete harvest and stripping, such fallen berries should be collected neatly and completely. They should be dried separately and should not be mixed with other coffee. Coffee obtained from gleanings will have earthy taste and possibility of mould contamination is likely in such coffees. By neat gleaning, infestation of CBB can be avoided.

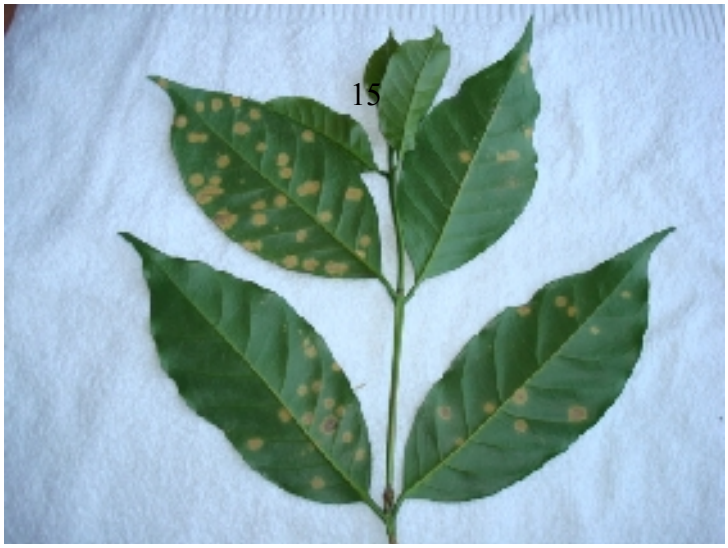
4. Leaf analysis

Coffee leaf analysis offers another type of approach in determining the nutrient availability of a soil and actual nutrient status in the plant itself. In order to determine the exact nutrient status in coffee plant, leaf analysis is very essential and a useful tool. The status of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and other micro-nutrients can be exactly determined by chemical analysis of the leaves and deficiency of any of the essential nutrient element can be identified to take appropriate step in time before it becomes a limiting factor in productivity of the plant. Simultaneous analysis of soil and complimentary leaf samples gives precise requirement of nutrients and helps in enhancing the accuracy of fertilizer recommendation services since these analyses are complimentary to each other.

The leaf analysis can be done ideally during February-March and September-November months. Fourth pair of leaves from growing tip of Arabica plant branches from the 2/3 height of the over all plant has to be collected randomly from the field. A minimum of 25 pairs of leaves from one hectare land is necessary for precise analysis. The leaf samples should be collected only during the morning time preferably before 10.00 a.m and placed between two sheets of blotting paper and packed in a perforated polythene bags and sent to the laboratory immediately. The details on the block history, age of the plant, fertilizers applied and crop harvested should be sent to the laboratory while sending the leaf samples. These samples are then washed with clean water and dilute hydrochloric acid to remove any superficial chemicals, dust and spray particles adhering to the leaf surfaces before processing for chemical analysis.

5. Pre-blossom Bordeaux mixture Spray

Humid cool weather with wind during May to November months, intermittent showers and sun shine, dry weather during December to March with cloudy weather (with mist) and drizzling during February-March months are very favourable to the early appearance of coffee leaf rust disease in plants. Thin or no overhead shade during the south-west monsoon is also one of the favourable factors for the development of this disease. In some places, the build up of CLR disease can be seen during February-March months itself. Generally during February-March months coffee leaf rust disease will be in its inactivity phase but under favourable conditions and in the places where very thin shades exist, then this disease can be seen during February-March months itself. In such areas, the plants have to be sprayed with 0.5% Bordeaux mixture (please see the Annexure for the preparation of Bordeaux mixture) or systemic fungicides (Contaf or Bayleton). This spray will prevent the disease spreading from the older leaves to the new leaves. The areas which are located in elevations more than 3500 feet are generally not affected by leaf rust disease during these months. While using the systemic fungicides, care should be taken to see that banned chemicals are not used for spray (see the Annexure).



COFFEE LEAF RUST SYMPTOMS

6. White Stem Borer Management

Coffee White Stem Borer (WSB) beetles attain their adulthood during April – May and October-December period and emerge out in large numbers. But when the environmental conditions are very favourable, then these beetles can emerge out from the plants throughout the year except during the monsoon. Adults are very active in bright day light. The beetles which emerge out during March-May months, lay eggs on the crevices of the plant bark which hatch and attain adulthood during next October-December months and emerge. The beetles which emerge during October-December will lay eggs and 15-20% of it will attain adulthood and emerge during next April –May months itself. The rest of the population (80-85%) from these progeny will emerge only during next October-December period. Hence, timely control measures are very critical in managing these insects. Any laxity in timely measures will result in greater damage to the plants and in turn the production.

Variations in climatic conditions like very low rainfall, very low moisture, improper shade, highly defoliated plants due to defoliation caused by leaf rust, exhaustion of plants due to high crop and improperly nutrient supplied plants will be the first casualty and more susceptible and amenable for WSB attack. Generally one of the broods of WSB beetles achieves adulthood during February-March. But, if the environmental conditions are favourable like increased temperature and sudden drop in the moisture content of the coffee plant stem, these beetles are capable of completing their life cycle early. If the outside temperature is above 35^0C but cloudy, the beetles will not emerge even if they are ready for flight. But, if it rains followed by bright sun shine after sometimes, these beetles will emerge immediately. Therefore the early emergence of WSB during February cannot be ruled out. Hence, one should take proper control measures should be initiated during February month itself if such favourable conditions prevail in the region.

As a first step, plants infested with borer should be traced, uprooted and immediately destroyed by burning or be immersed under water for a week. If the borer has not reached the root region of the plant, such plants can be collar pruned at 9 to 12 inches from the ground level (cut should face east direction) and suckers be allowed. The plants should not be collar pruned above one foot height as there is a

COFFEE WHITE STEM BORER

danger of again WSB attacking such cut stems and also such cut stems may dry up and die.

During these months shade regulation or timber extraction is not a good practice. The centring of the plants should not be taken up during this period. If the plant stems are smoothened during September months, such stems need to be further smoothened and while smoothening care should be taken to see that green part of the stems are not damaged. The smoothened stems are then given 10% lime wash (10 kg spray lime + 100ml Fevicol DDL in 100 litres of water).

In order to know the untimely emergence of beetles, small number of pheromone traps can be installed in the field in strategic places. WSB pheromone traps (25 traps per hectare) have to be installed in highly infested areas.

7. Compost preparation

Composting is a process wherein larger particles of biodegradable materials are broken down into smaller ones by the action of soil micro and macro organisms.In coffee estates lot of coffee and shade tree leaf litter, plant prunings, weeded materials, other green plants, coffee pulp, coffee skin, cherry or parchment husks and other bio-degradable waste materials are available. These materials have good plant nutrient values and there is a large potential for exploitation of the manurial values of these materials. They form good source for the preparation of compost in the estates. These materials can be mixed with coir pith, cow dung and other domestic wastes for increasing the manurial value of the compost. However, the quantity of compost prepared in the estates depends on the quantity of the raw materials available on site. The coffee effluent obtained during the course of pulping and washing can be used to prepare the compost especially for moistening the compost heaps. The coffee skin obtained during the pulping of coffee be mixed with farm yard manure and other domestic wastes and can be converted into good vermin compost using different strains of earth worms which are available in the Agricultural Universities.

8. Pruning

After the receipt of one or two summer showers, coffee plants start producing new shoots. This is the right time for pruning. Pruning essentially a thinning process to direct the vigour of the plants into those parts which produce crops. Pruning is to remove the unproductive wood for encouraging the growth of new branches which would become next years cropping wood. Pruning facilitates the entry of adequate sun light and air to all parts of the bushes thereby reducing the

incidence of pest and diseases and helps maintaining the frame work of the plants in desired shape.

In some plantations, there is a practice of pruning the coffee plants immediately after the harvest. But pruning operation should not be started until one or two summer showers (minimum of 2 inches of rain) are received. If sufficient moisture is present in the soil after the harvest, then pruning can be done immediately. The plants generally under stress due to mechanical injuries caused during the harvest. Under this condition if pruning is done in the absence of soil moisture, the plants suffer further stress because of the pruning operation resulting in poor future development of cropping woods. However, pruning can be done immediately after the harvest whenever the plantations are situated above 3500 feet as in these elevations the weather will be cool. Precaution should be taken not to prune deeply exhausted or diseased or die –back affected plants until sufficient rain is received as indicated above. It is recommended to practice only light pruning involving removal of old unproductive wood, criss-cross branches, branches touching ground, lean, lanky and whippy wood and pest and disease affected branches as well as branches growing towards main stem and ground.

9. Basket nursery

For basket nursery one should use the polythene bags of the dimension 6 X 9 (b X h) inches of 150 gauges. If lower gauge bags are used, there is a chance that the bags may break when soil is filled. Use of lower dimension backs severely hinders the healthy development of roots. Further, 12 uniform holes (3 mm) at equidistance should be made on the nursery bags to facilitate easy air circulation for the growing seedlings as well as to allow the excess water to flow out. Stagnation of water in the bags results in the rotting of seedlings.

A nursery mixture of 6 parts of sieved jungle soil(free from nematodes and other pests), two parts of well rotted cattle manure or compost and one part of coarse river sand (do not use sea sand as it contains sodium which is harmful to the seedlings) should be prepared and mixed well to fill the nursery bags. If the jungle soils are not available, it can be substituted with sieved surface soil mixed with compost or vermin compost. Prior to planting, the nursery bags should be gently watered and a vertical hole of about 5 cm deep should be made in the soil at the centre of the bags. The coffee seedlings at button stage are transplanted into the nursery bags. Seedlings should not be planted deep in the nursery bags and after planting, the seedlings should be watered daily in the morning times. Nursery should be cleaned off from weeds and other plants regularly. Provide overhead pendal shade till the commencement of regular monsoon.

There is a possibility of Cercospora (Brown-eye- spot) disease infecting the tender leaves of the seedlings in the nursery. To prevent the disease, spray Indofil -M-45 solutions (5 g/1 litre of water) or Bavistin (1g/litre)

Now a days, another fungal disease is also seen in the nursery this is caused by a fungus called *Myrothecium roridum*. In the case of attack the nursery plants show infection of the stem portion and leaves. The symptoms observed are water soaked brown to greyish white discolouration followed by defoliation of the leaves and death of the seedlings. To prevent and cure this disease, spray 0.8ml of Tilt (propiconazole) in one litre of water. This spray should be done once in a month till the end of the monsoon. In case of earthworm problem in the nursery and nursery baskets, this can be prevented by pouring soap nut solution. The

solution can be prepared by finely crushing fresh soap nuts and squeezing them in water.

Before transplanting the seedlings in the field, remove and destroy all the suspicious, stunted and disease affected seedlings from the nursery and plant only vigorous and healthy seedlings to avoid any future problems in the field.

COFFEE SEEDLINGS IN NURSERY BAGS

CULTURAL OPERATIONS TO BE CARRIED OUT DURING APRIL-MAY MONTHS

1. Line Marking for planting
2. Pitting
3. White Stem Borer Management
4. Pruning
5. Pre-monsoon Manuring
6. Pre-monsoon Bordeaux mixture spray
7. Shade lopping
8. Cradle pit/ water catch pit renovation
9. Weeding
10. Sucking pest (green mealy bug) management

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1. Line Marking for planting

While choosing the site for coffee planting due consideration should be given to elevation, slope, aspect, soil type, rainfall, wind speed, shade trees, availability of perennial water source and transport facilities. North, East and North-East aspects are suitable for growing coffee. Western aspect is not suitable because plants suffer from scorching sun. If one wants establish plantations in lands facing Western aspect, then proper thick shade cover has to be provided to protect plants from direct sunlight. Before new planting, shade trees have to be planted in adequate numbers in advance to give protection to the young plants. If already the land is covered with trees, then while regulating the plant density, selective retention of desired species should be done.

The planting land should be divided into blocks of convenient size with proper foot paths and roads for transportation laid out in between. Dadap plants have to be planted in the blocks at a distance of 20 feet apart during June month to provide temporary lower canopy shade. Within each block, the points for planting coffee seedlings should be located by marking the distance between the rows and plant distance. The following are the optimum spacing for different coffee cultivars:

(a) Arabica Talls - 7 X 7, 7 X 6 or 6 X 6 feet
(b) Arabica Dwarf/Semi Dwarf – 5 X 5 feet

Intensive cultivation is required when closer planting system is required. Once the land is marked, the soils from each block have to be tested and required amount of agricultural lime should be applied to correct the soil pH for the optimum growth of the plants. In steep slopes it is suggested to adopt contour planting so that soil erosion can be prevented and this method also helps in easy operation of the cultural practices. Square system should be adopted in gentle or flat lands.

2. Pitting

Pits for coffee planting are to be opened after few summer showers during March month. If, summer showers are delayed, this work can be deferred till the showers are received. The pits measuring 1.5 X 1.5 X 1.5 feet length, breadth and depth are ideal for planting. After opening, pits are to be exposed for weathering for 15 – 20 days. Later, add 1.0 – 1.5 kgs of compost/farm yard manure and 50-100 gms of rock phosphate in each pit and close the pits by filling in with the surrounding top soil. A small bamboo stick or wooden pole can be inserted at the centre of the pit for identification.

3. White Stem Borer Management

All the control measures adopted during the month of February-March months should be continued. Generally the incidence of white stem borer will be on the higher side wherever the shade is less and also wherever silver oak shade trees are more. In order to minimize the incidence of WSB, optimum shade has to be maintained/ created; this will help in the healthy growth of the plants also. There is a practice of shade regulation during the month of April in some coffee areas. If adequate blossom and backing showers are not received in time and even during April, then shade regulation work has to be postponed till sufficient moisture builds up in the soil. This will help in maintaining cool atmosphere in the coffee estates and brings down the activities of WSB. Borer infested plants have to be thoroughly traced, uprooted and burnt. The main stem and thick primaries of the plants have to be smoothened with coir gloves and smeared with 10% lime solution. Install 25 pheromone traps per hectare if the incidence level is high. Remember, retention of borer infested plants results in greater damage and economic loss during the coming years compared to retaining them for a meagre profit expected during the current year.

4. Pruning

When one or two summer showers are received, coffee plants start producing new shoots. This is the right time for pruning. Pruning essentially a thinning process to direct the vigour of the plants into those parts which produce crops. Pruning is to remove the unproductive wood for encouraging the growth of new branches which would become next years cropping wood. Pruning facilitates the entry of adequate sun light and air to all parts of the bushes thereby reducing the incidence of pest and diseases and helps maintaining the frame work of the plants in desired shape.

In some plantations, there is a practice of pruning the coffee plants immediately after the harvest. But pruning operation should not be started until one or two summer showers (minimum of 2 inches of rain) are received. If sufficient moisture is present in the soil after the harvest, then pruning can be done immediately. The plants generally under stress due to mechanical injuries caused during the harvest. Under this condition if pruning is done in the absence of soil moisture, the plants suffer further stress because of the pruning operation resulting in poor future development of cropping woods. However, pruning can be done immediately after the harvest whenever the plantations are situated above 3500 feet as in these elevations the weather will be cool. Precaution should be taken not to prune deeply exhausted or diseased or die –back affected plants until sufficient rain is received as indicated above. It is recommended to practice only light

pruning involving removal of old unproductive wood, criss-cross branches, branches touching ground, lean, lanky and whippy wood and pest and disease affected branches as well as branches growing towards main stem and ground.

5. Pre-monsoon Manuring

After the harvest and pruning, coffee plants will be generally in an exhausted and weak condition. Once the summer shower is received, we can see immediate growth activities in the plants and they start to produce new shoots. During this phase, it is essential to supply plant nutrients in required quantities through soil application of fertilizers.

In every coffee estate, the grown up plants need 50:50:50 kgs of nitrogen, phosphorus and potash per hectare for their vegetative growth. This is called sustenance nutrient dose which has to be given compulsorily to keep the plant health in good condition. The sustenance dose of fertilizer does not depend on the level of crop harvested or in the bearing but needed for the proper growth of roots, stem and vegetative parts.

The remaining quantity of annual fertilizer requirement of coffee plants are calculated based on the age and health of the plants, soil test values and crop level as well as the average crop harvested during the last five years. Therefore it is essential that the soils have to be tested for their fertility status routinely in order to avoid under or over fertilization in the field. The calculated amounts of fertilizers need to be applied in 2 to 3 splits. One of the split doses of fertilizer has to be given during the pre-monsoon period i.e. after receiving sufficient amounts of summer shower.

Before the application of pre-monsoon fertilizers, the plants should be relieved of their unproductive and undesired growths (pruning) and should complete weeding operation. Based on the recommended levels of fertilizers and area to be fertilized, suitable quantity of fertilizers should be uniformly mixed and applied in the field.

The maximum fertilizer use efficiency will be obtained when they are placed around the plant instead of broadcasting. Therefore, all the mulch shall be cleared around the plant up to the plant canopy area leaving one foot distance from the main stem. The soil in this area is then slightly disturbed using the forks and fertilizers should be uniformly applied in this area. After the application, the soil has to be reworked so that all the fertilizer particles are well covered and finally re-mulch the soil with the previously cleared mulch. One should note that a single split dose of fertilizer should not exceed 100:75:100 kgs of N: P: K per hectare. If larger quantity of fertilizers is given in a single split there is a high chance of loss of nutrients due to volatilization. In highly productive blocks, the number of split doses will be more than 3-4 splits. The plants during the blossom/after blossom and pre-monsoon period essentially require phosphorus nutrient and hence, one should not skip phosphorus application during this period. It is advised that all the farm wastes like fruit skin, mucilage and cherry or parchment husks shall be composted in the estate and recycled in the farm.

6. Pre-monsoon Bordeaux mixture spray

April and May are the most crucial months for the spreading of coffee leaf rust disease from the older leaves to the young tissues. During this period, because of shade regulations in estates, generally the shade will be thin which helps the faster spreading of the disease. Therefore during this period, spray of 0.5% Bordeaux mixture is very important which prevents the spread of disease and protects the young leaves. Freshly prepared Bordeaux mixture has to be sprayed on the **lower surface** of

the leaves. Spraying the Bordeaux on the upper surface of the leaves does not ensure protection from the spread of the disease. About 15 barrels of the spray mixture adequately covers one hectare of the area. The protection measures shall be completed by first week of June every year. Please ensure that the pH of the Bordeaux mixture is maintained between 9 and 10 for the best efficiency of the sprayed mixture. Do not mix any fertilizers (except potash), micro nutrients, insecticides, pesticides or plant growth hormones in the Bordeaux mixture as these ingredients are bound to decrease the efficiency of the B.mixture. However, 350 gm of MOP can be added to one barrel of the mixture as potassium is compatible with Bordeaux mixture. There is a common practice of adding urea to the Bordeaux mixture. This is a bad practice which should be avoided. Mixing of urea in the mixture leads to the loss of nitrogen in the form of ammonia as well as results in lower efficiency of the spray solution. Black rot affected patches should be sprayed with 1.0 % Bordeaux mixture during the first week of June.

I case of delayed blossom shower (May 2nd to 3rd week), we can not see the growth of new shoots in the plants and hence spraying of Bordeaux mixture under this condition should be avoided. In such an event, spray of 7-8 barrels per hectare systemic fungicides (160 gm of 25 WP 0.02% Bayleton or 400 ml of Contaf-5EC-0.01% in 200 litres of water) during the break in the monsoon which will help in controlling the CLR disease.

7. Shade lopping

Coffee requires optimum filtered shade for its best performance under Indian conditions. Therefore it is essential to regulate the shade trees regularly in order to provide required light intensity to the coffee plants. Generally May is the ideal month for shade regulation. Shade regulation should not be undertaken if dry weather and lack of moisture in the soil prevails in the field. Shade regulation under this condition further increases the soil moisture loss leading to wilting of plants and decreased new shoot formation which will adversely affects the next year crop. The white stem borer activities can also increase leading to higher infestation on coffee plants. Therefore, shade regulation shall be done preferably only after receiving 4-5 inches of rainfall. Meticulously and properly regulated shade helps in minimizing the biennial bearing habits of coffee plants, avoids die-back and wilting of plants. All the drooping branches of shade trees at a height of 9-12 metres above the coffee plants should be removed so that filtered light penetrates into the ground.

Similarly, the lower tier shade (dadap) should also be regulated. As soon as monsoon sets in, the branches of all the dadap plants should be removed. The lopped small branches shall be finely chopped and all the leaf compliments obtained during the shade regulations shall be spread all over the ground and allowed for rotting. After the monsoon, dadap plants needs to be regulated depending on the growth of dadap plants. The dadap stakes can be used for planting in other areas.

8. Cradle pit/ water catch pit renovation

In slopy areas, the cradle pits are generally opened during October-November months. These pits get filled during the north-east and S-W monsoon period and hence needs renovation once in 2-3 years. All the deposits like washed soil, leaf litter, weed bio-mass and tree debris shall be removed from these pits and spread near the

surrounding plants. April-May months are the ideal period for the renovation of these pits. Similarly, before the onset of the monsoon all the drainage channels should be cleaned and connected to the main catch pits. If these channels are not renovated, water will stagnate in these channels and pits which causes damage to the coffee plant roots due to chilling effect causing wet feet disorder in plants. Wet feet disorder causes defoliation in plants. In water logging areas (flat areas), drainage channels of 1.5 feet breadth and 1 foot deep should be opened up at suitable distances between the rows to drain out excess water from the field. These drainage channels should be connected to the water catch pits opened at the end of the field. Proper drainage system provided in the coffee fields helps in improving the soil structure, root respiration and development. Collecting excess water in catch pits increases the water table in the ground.

9. Weeding

The weeds shall be cleanly slashed before the start of monsoon. Slashed weeds shall be spread uniformly in the field.

10. Sucking pest (green mealy bug) management

Green mealy bug is one of the most important sucking pests of coffee. Various types of ants especially red ant and cocktailed ants are responsible for the spread of these small soft bodied insects from one place to other. Hence control of these ants is important in mealybug management in the coffee fields. Therefore, control ants by dusting 5% Malathion powder around the base of affected coffee plants and shade trees. Destroy nests of red ants and cocktailed ants. The infested plants should be sprayed with Ekalux 25 EC (120ml) or Metacid 50 EC (120 ml) dissolved in 200 litres of water with 200 ml of any agricultural wetting agent using a gator sprayer. Four litres of kerosene emulsified with 200 litres of water and 200 ml of wetting agent can also be used for spraying.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING JUNE-JULY MONTHS

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1. Dadap planting.

Temporary shade i.e. lower canopy shade (Dadap) is very important for coffee during the drought period. These shade trees protect the coffee plants from bright sun shine during the summer heat. It is very essential to provide adequate shade to coffee plants during summer period by proper maintenance of both temporary and permanent shade trees. Dadap plants are grown to provide lower tier shade to coffee plants in coffee estates. The dadap stakes should be planted in the coffee fields during June-July months as sufficient moisture is present in the soil during these months which helps in early rooting of the stakes. However, in marginal areas where soil is gravel and soil moisture is deficient, the dadap plants do not root easily. In such cases, after planting dadap plants, the planting pits have to be treated with 1-2 litres of hormonal solution (1 ml of hormonal in 1 lit of water) which helps in early rooting of dadap plants. Use dadap stakes of 1-1.5 metre height and a minimum of 5-6 cm girth for planting. After one month of planting apply 25 gm of super phosphate to each plant for better development of roots and growth of the dadap plants.

2. Shade tree planting

June-July months are ideal for planting shade trees. It is always better to have mixed shade trees rather than having mono shade like silver. Planting only silver oak trees does not ensure filtered shade. The temperature of the field is generally higher in the estates where silver oaks are planted as shade trees. Further, the silver oak leaf litter does not degrade as quickly as other leaves. The black rot disease and white stem borer incidence are more prevalent in estates with silver oak as shade tree. Therefore, it recommended that in coffee estates more of other shade trees have to be planted like *Indian fig, atti, bili basari, mallegargatti, rose wood, jack, gandagarige* and trees belonging to leguminous family. In high rainfall areas, the plants which shed leaves during the monsoon but quickly foliate after the monsoon have to be chosen. The trees like A*tti or Balanji* belong to this category. Planting of trees like *neeli* in the estates should be avoided as these trees harbour caterpillars. Permanent shade trees should be planted at a distance of 12-15 metres. In wind prone areas, silver oak and silk cotton trees have to be planted densely round the boundary of the estate.

3. COFFEE PLANTING

Undesired and suspicious coffee seedlings should be removed from the nursery and destroyed. Only healthy disease free and more vigorous seedlings of the desired variety should be selected from the nursery for planting in the field. Sixteen to eighteen months (root plants) old seedlings can be planted during June-July months in the planting pits opened earlier. At the time of planting, a hole should be made in the centre of the pit after levelling the soil and seedlings are planted in these holes. Add 5 gms of thimmet or forate crystals to the pit before planting the seedlings to avoid cockchafer problems.

The tap root and the lateral roots are to be spread out in proper position before packing with the soil. In the case of ball plants, the polythene bag is cut at the bottom and tip of the tap root is nipped if it is found bent. Care should be taken so that soil around the seedlings is packed slightly above the ground level (one inch) to prevent water stagnation around the collar region of the seedlings. Avoid deep planting. Care should be taken to see that the planting pits should not contain gravel or stones at the bottom so that formation of bent root can be prevented. The planted seedlings are then provided with cross-stakes to prevent wind damage and mulched with dry leaves.

4. HANDLING AND CENTRING

Pruned plants start producing more and more new shoots after the receipt of sufficient showers. This necessitates one or two rounds of handling once during June-July months and later during August-September. During the handling operation, the new flush arising after the main pruning is thinned out to a desired number (2 per node) of well spaced branches.

Centring should be done by the removal of new shoots arising within half foot radius of the main stem. This facilitates good air circulation and penetration of light into all parts of the plant as well as prevents the black rot disease. Centering is a skilled work; too much opening of the centre of the plants may invite trouble from White Stem Borer. Desuckering has to be done by removing the suckers growing from the main stem. Gourmandizers should not be retained. There is a practice in some estates allowing the gourmandizers for many years. This practice should be discontinued as it spoils the plant frame work and all the lower branches will be affected in due course. All the criss-cross branches should also be removed. By removing all such undesired growth, the fertilizer use efficiency by the plants can be increased.

5. BLACK ROT MANAGEMENT

Continuous rain without a dry spell, saturated atmosphere with 80-100% relative humidity, breeze, thick overhead shade and hanging mist during the monsoon period causes the outbreak and spread of Black rot disease. This disease is more prevalent in valleys and in the estates with full of silver oak shade trees. The black rot pathogen infests leaves, developing berries and young shoots. Diseased leaves, berries and shoots turn black, start rotting and fall. On green berries the characteristic blackening starts from a side and spreads gradually in a narrow band. If this disease is not controlled, it is potential enough to cause 10-20% crop loss.

In the areas prone to black rot disease, thinning of the overhead shade should be done before the onset of monsoon. Centering and handling of the bushes by removing criss-cross branches, dead and dry branches, suckers and dried fallen leaves of the shade trees on the canopy of coffee plants should be meticulously attended and

removed. As soon as the symptom of the disease is noticed, all the affected leaves and berries should be removed and destroyed. In affected areas spray 1% Bordeaux mixture on both the surfaces of leaves and to the developing berries just before the onset of monsoon and during the break in the monsoon. Affected areas can also be sprayed with Bavistin 50 WP @0.03% a.i (120 gms in 1 barrel of water) just before the monsoon and also during the break in the monsoon period. Do not spray Bavistin during the rain.

6. **WEEDING**

If the growth of the weeds is seen, slash weed them

7. **NURSERY**

Remove the overhead pendal completely. Provide adequate drainage in the nursery so that rain water does not stagnate. All the weeds in the nursery has be cleared.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING AUGUST-SEPTEMBER MONTHS

1. **Planting and Gap filling**
2. **Mid monsoon manuring**
3. **White Stem Borer Management**
4. **Coffee Berry Borer Management**
5. **Post monsoon Bordeaux mixture or Systemic fungicide Spray**
6. **Post monsoon Manuring**
7. **Indenting for Seed coffee**

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1. Planting and Gap filling

6-8 month old basket seedlings can be planted in the field. Please follow the method of planting (refer in June-July operations). Gap filling should be done with the same variety. Do not practice planting different varieties of coffee in the same block. Different varieties perform differently in the same block in terms of growth, quality and productivity. Therefore, planting different varieties in the same block will disturb the field uniformity as well as results in inconsistent cup quality. Further, the level of disease and pest resistance of different varieties is different from each other.

Provide adequate protection to the plants from cattles and monkey menace. Protect the plants from cockchafer pest during the initial years of planting. Keep the weeds away from the new planting site as they compete for applied fertilizers with the coffee plants. Weeds are more efficient than coffee plants in absorbing applied nutrients and hence keep them away. Mulch every new coffee plant and provide them protection from wind by placing cross stakes. Wherever, shade protection is deficient, hutting should be done.

2. Mid- monsoon manuring

During the monsoon, nutrient nitrogen is lost very fast due to leaching. Plants need nitrogen during this period in order to produce more of shoots and branches. It is necessary to provide nitrogen to the plants to balance the nitrogen loss due to leaching. Therefore, apply 58 kgs of nitrogen (2.5 bags of Urea) per hectare during the break in the monsoon. This mid monsoon application of urea also helps in reducing the berry drop.

3. White Stem Borer Management

Borer infested plants should be properly traced, uprooted and destroyed by burning on the same day. Otherwise, the uprooted plants have to be immersed under water for 8-10 days. In case the borer has not reached the root system (at least 9 inches above the ground), such plants can be collar pruned at a height of 9-12 inches from the ground and new suckers can be allowed. Do not store the uprooted infested plants. Storing of infested plants hastens the life cycle of the borer and they emerge faster than usual infesting healthy plants.

During the September month after the cessation of rain, the coffee stems are soft and this is the right period for stem smoothening using coir gloves. Thick

branches of the plants should also be smoothened. Do not use sharp tools for smoothening the stems and branches. Care should be taken to see that the green parts of the stems are not damaged during this operation. Any damage caused to the green portion of the stems results in death of the plants as well as infestation by fungus causing stem canker disease. Egg laying activity of the borers can be avoided by proper smoothening of the stems. Apply 10% lime solution to the smoothened stems and branches.

WHITE STEM BORER PHEROMONE TRAPS

4. Coffee Berry Borer Management

Coffee Berry Borer has to be controlled using *Beauveria bassiana* spray using bakpak sprayer.

Method of preparation of *Beauveria bassiana culture*

In 375 ml glass bottle add 50 gm of rice and 50 ml of water. Plug the mouth of the bottle with cotton ball. Place these bottles in an aluminium container filled with water to a height of 50cm. Close the container with its lid and steam the bottles inside for about 20 minutes. Bottles are then cooled to the room temperature and inoculated with the *Beauveria bassiana* fungal culture. In about 3 weeks, the culture will be ready for use in the field. Immersion and thorough soaking of this culture in one litre of water with wetting agent gives the *Beauveria bassiana* fungal solution. This solution can be sprayed on the infested berries. This fungus is effective only when applied immediately after the cessation of monsoon when there is high humidity in the field. Spraying of the solution should be done before the hardening of the beans.

5. Post monsoon Bordeaux mixture or Systemic fungicide Spray

The coffee leaf rust disease intensifies during September month. In this period, pale yellow spots on the lower surface of leaves are seen and later these spots turn

orange yellow powdery mass. If the disease is not controlled at this stage, it intensifies further resulting in defoliation. If the leaf compliments in the plants are lost, then it effects the development and maturity of beans. Defoliation also exposes the plant stems and stem borer can easily attack the plants. As a control measure spray 0.5% Bordeaux mixture (15 barrels per hectare). The lower part of the leaves should be properly covered with the spray mixture.

In case of heavy disease incidence, systemic fungicides have to be sprayed. In such an event, spray of 7-8 barrels per hectare systemic fungicides (160 gm of 25 WP 0.02% Bayleton or 400 ml of Contaf-5EC-0.01% in 200 litres of water). Do not mix systemic fungicides in Bordeaux mixture. The effect of the systemic fungicides starts in about 2-3 weeks and lasts for nearly 2 months. If the rain does not stop during September, then this spray can be undertaken after the cessation of rain.

6. Post monsoon Manuring

Nitrogen is the most important plant nutrient and plants need it throughout the year. Nitrogen helps in the development of new shoots and berries. Nitrogen also helps in the production of large number of flowers and retention of leaves for a longer time. Adequately nitrogen supplied plants produce dense beans of higher quality.

Potassium is another element which is essential for the fruit setting, bean filling, maturation and hardening of the beans. It improves the vigour and the pest and disease tolerance of the plants. Phosphorus is needed for the healthy and strong development of roots and shoots.

After the monsoon, recommended doses of fertilizers have to be applied. Though the placement of fertilizers (pegging) is very efficient in terms of utilization, the process is laborious and time consuming. Therefore, simple method of application is suggested as under. Remove, the mulch under the plant canopy leaving one foot circle around the main stem. Slightly disturb the soil in the de-mulched area with forks. Broadcast fertilizer uniformly and evenly in this area and rework the soil. Cover again with the removed mulch. This method is very efficient and it avoids volatilization and washing away of nutrients. In steep areas, fertilizers can be applied in semi arch form on the upper side of the stem down the slope.

7. Indenting for Seed coffee

Seed coffee for the preparation of nursery should be procured only from the Central Coffee Research Institute and its other Sub and Regional stations and through Extension wing of the Board. Growers are advised to book their seeds by advance payment either at CCRI or with the extension offices not later than September.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING OCTOBER-NOVEMBER MONTHS

1. **Weed Control**
2. **Cleaning of pulper and Drying Yards**
3. **Arabica Coffee Harvesting**
4. **Coffee Processing**
   - **(a) Arabica Parchment Preparation**
   - **(b) Arabica Cherry Preparation**
5. **Seed Coffee Preparation**
6. **White Stem Borer Control**
7. **Soil Testing and Liming**
8. **Soil Digging (Cover digging)**
9. **Coffee Effluent Management**
10. **Opening of Cradle Pits**
11. **Hutting**

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1. Weed Control

Different types of weeds grow in coffee estates and they compete with coffee plants for moisture and mineral nutrients. If the weeds are allowed to grow during the late post-monsoon period, they use the soil moisture which coffee plants need in the following dry season. Free growth of weeds reduces the yield of coffee plants as well as their growth. Therefore, it very important to control the weeds in the field. In young plantations weeds are the major problems during the initial years. In new clearings, the weeds should be removed by slash weeding at least 3-4 times in a year. While in established fields, 2-3 times this operation has to be carried out. All the slashed weeds should be spread in the field during the rainy season for rotting and bio-degradation. Weeds which have the habit of flowering should be removed before they flower. After the monsoon, clean weeding should be done in the entire estate.

In established plantations, recommended weedicides can also be used. But one should note that, the sprayers used for spraying weedicides should never be used for spraying any other chemicals without ensuring 100% cleaning. Use WFN 062 or WFN 040 flood jet nozzles for spraying weedicides. The use of weedicides should be judicious and as far as possible the use should be restricted to the most minimum level to avoid environmental contamination. Weedicides along with wetting agent should be applied on a bright sunny day when there is sufficient moisture. The soil moisture helps the faster absorption of the weedicides by the weeds.

In the new clearing, the fields should be given a thorough cover digging to a depth of 9 inches towards the end of monsoon and all weeds, vegetative wastes and debris should be completely turned over and buried into the soil. In young clearings, coffee planted at normal spacing covers only a small portion of the ground and therefore weeds grow prolifically. In such spaces growing of green manure crops, cover crops, legumes, beans, pigeon peas, sweet potato and vegetables are recommended as these plants hinder the growth of weeds. The crop from these plants can either be harvested or these plants can be cut and incorporated in the soil again. In 2-4 year old plantations, the soil has to be scuffled to a depth of 0.25 inches (7.5 cm) or cover crops have to be grown.

Recommended Weedicides

Paraquat-di-chloride 24% EC @ 0.067% active ingredient (a.i.)
For example dissolve 500 ml of Gramoxone in a barrel of water and spray.

Or

Glyphosate 41% EC @ 0.27% a.i.
For example dissolve 1200 ml of Round up or Glycel in a barrel of water and spray.

The cost and the quantity of the weedicides can be brought down by nearly 50% by the addition of 2 kgs of Urea to the spray solution without affecting the efficiency of the spray solution. By adding 2 kgs of urea, the dosage of Gramoxon could be reduced to 250 ml while the quantity of Round up/Glycel could be reduced to 600 ml per barrel.

2. Cleaning of pulper and Drying Yards

Before the start of the coffee harvest, the equipments/tools used for coffee processing namely pulper, pulper yard, pulper vats, washer, coffee raker, fermentation tanks, siphon tank should be thoroughly cleaned. The pulper discs and choppers should be properly adjusted to the size of the fruits to prevent cuts. The weeds, soil and algal growth in the drying yards should be removed and washed with clean water before use.

3. Arabica Coffee Harvesting

In order to maintain and protect the coffee beverage quality, aroma, thickness of the brew, taste and flavour as well as acidity in the cup, the right kind of coffee fruits have to be harvested in right time following certain suggested guidelines. Improper harvesting will result in spoiling the cup quality even if the coffee plants are known to belong to top quality category. Therefore, following the right kind of harvesting procedure will help in protecting the inherent quality as well as helps in getting premium prices.

Coffee fruits have to be picked as and when they become ripe; this can be understood by gently squeezing the fruit with fingers. On gentle squeeze, the bean inside the fruit pops out easily. Under ripe or over ripe fruits should not be mixed or used for the preparation of parchment coffee as they can spoil the overall cup quality. The under ripe coffee fruits result in the production of immature beans and the over ripe ones cause foxy coffee resulting in brown beans with fruity cup. If the harvest is not possible as and when fruits rightly mature, the under ripe and over ripe fruits needs to be separated from the lot and only right kind of desired fruits have to be pulped in the course of preparation of parchment coffee.

The under and over ripe fruits can be converted into cherry coffee. While harvesting the coffee, picking mats should be used, this helps in easy collection of fallen fruits and prevents the mould formation. Prevention of mould formation avoids the production of Ochra Toxin-A in coffee beans. Use of picking mats also reduces the Coffee Berry Borer infection. One should note that, clean gunny bags or plastic bags should be used for collecting the fruits during harvesting. These bags have to be regularly washed with clean water, dried and used for collecting the fruits. Bags used for storing chemicals, fertilizers, pesticides, insecticides and fungicides should never

be used for harvesting coffee fruits. No fruits should be allowed to remain in the plants after the end of season harvest as it can invite berry borer infestation.

4. Coffee Processing

(a): Preparation of Parchment coffee

Parchment coffee or plantation coffee can be prepared by pulping, cleanly washed with water and dried under sun. Preparation of such coffee requires pulping equipments and adequate supply of clean water. The quality of parchment coffee is always superior to that of cherry coffee (whole fruit dried under sun). Cherry coffees always give fruity taste as the beans are in contact with the mucilage for a longer time during the course of drying period. Therefore, wet processing of coffee is essential to get superior quality coffee and the method can be followed wherever, all the adequate facilities like sufficient clean water and good processing machineries are available.

The pulper, pulper tanks, siphon tanks, rakers, washer, fermentation tanks should be thoroughly cleaned before the pulping operation is undertaken. The premises of the pulper unit as well as the drying yards should be kept in hygienic way. The pulper unit should be properly adjusted depending on the fruit size and checked every day to prevent cuts. Pulper nipped and other deformed beans will yield defective low quality parchment.

The pulping and washing machineries and other equipments used in the preparation of parchment coffee should be cleaned on daily basis. No fruits, fruit skins or beans from the previous day's harvest should be allowed to remain and mix with fresh coffee fruits or pulped beans. These materials badly damage the parchment coffee quality. Only clean water shall be used for processing coffee fruits and all the extraneous matters such as leaves, twigs and stones should be thoroughly removed from the fruits before pulping. If adequate supply of water is not available, then the water used for pulping the fruits can be recycled to pulp the fruits second time. The pulped water however, should not be used on the second day. Further, pulped water should never be used for washing the coffee beans under any circumstances.

As far as possible, harvested fruits have to be pulped on the same day of the harvest. If, it is not possible to process all the fruits on the same day, such fruits can be stored under clean water and pulped on the second day. The fruits stored for more than 10 hours in the open heap without pulping will result in fruity cup. The fruit skins separated by pulping should be taken away from the pulping site as quickly as possible so that microbial decomposition of the skin does not affect the quality of parchment coffee.

The sticky mucilage on the pulped beans can be removed by 4 different methods. However, the commonly followed/adopted methods are two namely: (1) Natural Fermentation and (ii) : Aqua machine wash by friction.

Superior quality coffee can be obtained by natural fermentation method. Fermentation is a critical stage in processing and has a deep influence on the quality of coffee. When pulped coffee is stored in fermentation tanks along with the mucilage, natural hydrolysis of pectins present in coffee mucilage occurs due to the enzymes naturally present in coffee mucilage. In Arabica coffee, natural fermentation will be complete in about 24 to 36 hours. However, this may take longer time also when the ambient temperature is too low. The fermentation process should be controlled so that over

fermentation is avoided. Over fermentation will result in foxy beans and make the coffee cup sourish. The under fermented coffee results in imparting mustiness in the cup. The correctness of fermentation can be checked by rubbing the fermenting beans with hand. The mucilage will come off easily and the parchment does not stick to the hand after wash. The beans feel rough and gritty when squeezed by hand and a feeling similar to squeezing pebbles is felt. After the correct fermentation, the beans are cleanly washed 3 to 4 times in clean water or in a washing machine. The quality of the coffee can be further enhanced, if the washed beans are soaked under water for about 4 to 6 hours.

The parchment coffee prepared in such method initially contains around 50 – 55% water content in them. The superficial water content should be removed by spreading the parchment over wire mesh trays and then dried on clean cement or clay lined drying yards till the moisture content reaches a value of 11.0%. Generally parchment takes about 7 – 10 days for drying when spread at a thickness of 4 – 7 cm. If the parchment is spread too thin, rapid drying of coffee at this stage causes the parchment skin to split which lead to cracking of parchment, shrunken and boat shaped beans. Stirring and turning of parchment coffee at least once an hour is essential to facilitate uniform drying. The parchment should be heaped during the evening time and covered with polyethylene/tarpaulin sheets/gunny bags. Drying mass of parchment coffee should never be exposed to mist. Parchment coffee should not be exposed to the hottest sun between noon and early part of the afternoon especially on the 3rd and 4th day of drying. Exposing the parchment to the hottest sun during the 3rd and 4th day will result in wrinkled beans. Once the coffee is dried to a recommended moisture level of 11.0%, the coffee has to be bagged in clean and dry gunny bags. Coffee of different lots should be bagged separately. New gunny bags should be always turned inside out well aerated before use as otherwise the coffee will absorb natural oils and off odours from the bag and give rise to an “acrid” (bitter/pungent/harsh) cup. If the gunny bags are procured from curing works, the bags should be properly fumigated or the curing works should be asked to fumigate and supply to avoid the spread of Coffee berry Borer infestation. Coffee should be stored in well ventilated and dry store rooms. The coffee should be stored on raised wooden platforms to ensure proper circulation of air underneath the bags. Parchment coffee and cherry coffees should not be stored one over the other. The fertilizers, chemicals, oils, insecticides and pesticides should not be stored in the coffee godown.

(b): Preparation of Cherry coffee

To prepare cherry coffee, fruits should be picked as and when they are ripe. Greens and under ripe fruits should be sorted out and dried separately. All the extraneous matters like twigs and leaves should be separated from the fruits and dried. The fruits should be spread uniformly in the drying yards at a thickness of 7 – 8 cm. Clean cement or clay lined drying yards should be used for drying the cherry coffee. Use of cow dung smeared or mud drying yards should be avoided. Drying coffee in such yards causes mould formation in cherry coffee and quality of such coffees is very inferior. Coffee should be stirred and ridged at least once every hour to facilitate uniform drying. In the evening time cherry coffee should be heaped and covered with polythene or tarpaulin sheets to avoid contact with the mist. The coffee will be fully dry in about 10 -12 days under the bright weather conditions. Cherry coffee should be dried to a moisture level of 12 to 12.5%. The cherry is dry when handful of the drying

cherry produces rattling sound when shaken and a sample forlit records the same weight on two consecutive days. At the end of the harvest, the remaining fruits on the plants should be completely stripped and fallen fruits should be gleaned cleanly. If this method of complete stripping and gleaning is not followed, there is a danger of Coffee Berry borer infestation during the coming years. Stripped and gleaned coffee should be dried separately and should not be mixed with other coffee.

5. Seed Coffee Preparation

Select the vigorous, highly productive, pest and disease free coffee plants for collecting the seed coffee. While selecting the plants, only such plants which have not suffered from any diseases for a long time in the field should be selected. After selection of the plants, blossom should be forced on these plants by irrigation well before the general blossom shower. This will avoid any cross pollination from the undesired plants. From these plants select and harvest healthy ripen fruits. After the harvest, segregate floats and half ripe fruits and hand pulp the well matured fruits. The pulped beans are then mixed with sieved wood ash and dried slowly under shade in 5 cm thickness. Seed coffee should not be prepared from Berry Borer affected areas. Before sowing, the seeds should be treated with Bavistin (Mix thoroughly 1 gm Bavistin 50 WP with one kg of seeds) to avoid any fungal attack.

6. White Stem Borer Control

Adopt all the control measures to manage the coffee White Stem borer as explained in earlier pages.

7. Soil Testing and Liming

In order to grow healthy coffee plants and to realize better crop, it is very important to protect primarily the soil health. The various plant nutrients in the soil need to be maintained in balance so that the soils remain productive for a long time. The acidity (pH) determines the productivity of the soil and nutrient assimilation/mineralization in the soil. In order to have better fertilize use efficiency of the applied fertilizers, the soil pH should be maintained at around 6.1 in coffee soils. Due to the continuous application of acid causing fertilizers like ammonium sulphate, ammonium chloride and DAP and due to the leaching of calcium and magnesium elements in the soil, the soils tend to become acidic. Therefore, to monitor the soil pH, soils have to be tested compulsorily once in 2-3 years. When the soil pH goes above 6.2 or comes below 6.1, the soil pH needs to be corrected because the availability of essential plant nutrients depends on the soil pH. Strongly acidic soils (pH below 4.5) are relatively poor in productivity because of essential plant nutrient deficiencies or toxicities of essential or non essential elements. Highly acidic soils are harmful for the useful soil micro-organism and in such soils coffee plant growth is always tend to be stunted in nature. If the soils are alkaline (above pH 7.0), most of the essential plant nutrients are not available to the plants.

Whenever, the coffee soil pH falls below 6.1, the soil pH should be corrected by the application of alkali forming soil amendments like agricultural lime(Calcium Carbonate), dolomite (Calcium and Magnesium Carbonates). Liming of the coffee soils can be done anytime of the year except during monsoon period. However, keeping in mind the coffee zones, it is known that November to February months are the ideal period for lime application. One should take care that adequate moisture is present in the soil for the best use of applied lime. Liming materials has to be

uniformly broadcasted in the field. Finer the liming material, higher will be its efficiency and the soil pH gets corrected faster. Liming of the soil should be done only after soil test and the quantity of the liming material accordingly decided.

If the recommended dose of liming material is more than 3.5 metric tonnes per hectare, in such case the dose has to be split into two equal parts and applied in 2 years. The scientific use of lime on acid soils can appreciably improve the soil productivity and the plant uptake of nitrogen, phosphorus, potassium and micro nutrients. In the case of soil pH going beyond 6.2, then pH can be corrected by the application of acid forming fertilizers. It is recommended that each lime samples should be tested for purity before use in the field. This will help in deciding the correct quantity of the procured lime to be applied in the field based on its purity.

Soil Sampling

It is important that the soil samples collected should be the representative of the field to be tested. The important procedure to be followed for the best sample collection is as follows.

- The field has to be divided into blocks of 2 hectares each. Sample each block separately.
- When the areas within the field differ distinctly in growth of plants or appearance of the soils or known to have been treated differently, soil samples in such blocks should be collected and labelled separately.
- Do not collect the sample during rainy season. Do not send the soil samples for analysis which are collected long back and stored.
- Select at random 20 spots in each block, remove surface litter and dig a hole of 9 inches diameter using a suitable tool up to 9 inches depth. Scratch the soil samples uniformly round the hole from top to bottom and collect 1 kg of the sample and mix well to get the composite sample..
- Samples should not be collected from the blocks which are recently limed or fertilized. Do not collect samples from road side, old bunds, and marshy places or near the shade trees. Collect soil samples at the centre of 4 coffee plants.
- Dry the samples under shade and pack in a polyethylene bags or cotton bags and send to the laboratory properly labelled. Do not use fertilizer contaminated bags.
- Give the details of the estate, crop harvested for the last 5 years, elevation, rainfall details, irrigation schedules if any, variety of coffee and age of the bushes.

8. Soil Digging (Cover Digging)

In new clearing the field should be given a thorough digging to a depth of 15-18 inches towards the end of monsoon. All the weeds should be completely turned under and incorporated in the soil thoroughly. This operation shall be done only for two years after planting coffee. This will help in suppression of weed growth and conservation of soil moisture in new clearings. Avoid deep digging in steep slopes as it can lead to soil erosion.

9. Coffee Effluent Management

Letting out of untreated coffee effluent to natural water streams or to open lands is environmentally unsafe as it causes water and land pollution. Use of untreated coffee effluent for irrigation is also prohibited by the law. Since, coffee processing coincides with the dry season when amount of water present in the natural streams is at the minimum, causing further concern of higher degree of pollution.

The coffee effluents emanating from the pulper units are highly acidic and contains high amounts of dissolved and suspended biodegradable organic matters. These effluents, if discharged into natural water bodies without treatment, pollute the receiving bodies by depleting dissolved oxygen present in it. Polluting natural water bodies will have an adverse effect on domestic users, aquatic life, livestock and water course down the stream. The pollution load of coffee effluent is measured in terms of Biological Oxygen Demand (BOD) and Chemical Oxygen demand (COD). Depending on the quantity of water used to process one unit of clean coffee (1 M.T), the BOD and COD amounts vary in the effluent. The amount of BOD range between 8000 and 13,000 ppm and the COD levels will be around two times of the BOD present in the effluent. One should note that BOD levels will increase if pulped water is recycled during the processing.

In order to protect the environmental health and to control the pollution on account of polluted water reaching the natural water bodies, agricultural land and open spaces, Central Pollution Control Board (CPCB), Government of India has imposed certain laws and guidelines for handling effluents. These guidelines have to be followed mandatorily failing which the person is severely punishable under the law. As per the CPCB statute, the water to be used for irrigation should not contain more than 100 ppm of BOD and water to be discharged to natural water bodies should not contain more than 30 ppm of BOD. Since, coffee effluent contains more than the stipulated levels of BOD and COD, it has to be treated by following recommended methods of treatment before use in the field or discharging it to the streams.

Steps to be followed in the treatment of Coffee Effluent

- All the fruit skin shall be cleanly separated from the pulped water using suitable screens
- The coffee effluent coming out of the washer unit should be stored in a lagoon for one day. The capacity of this lagoon shall be of one day's water use capacity of the processing unit.
- This effluent should be neutralized with appropriate amount of Agricultural lime so that the pH of the effluent is around 6.9 to 7.0. Generally 5 grams of good liming material is adequate to neutralize 0ne litre of the effluent.
- After one day of storage, the effluent is allowed to the anaerobic lagoon. Before allowing the effluent to the lagoon, the anaerobic lagoon should be charged with 4% cow dung slurry up to 10% of the capacity of the lagoon. Charging of the anaerobic lagoon should be done one month before the pulping operation starts so that the methogenic bacteria present in the cow dung slurry which are responsible for the degradation of the biological materials get stabilized. The capacity of the anaerobic lagoon should be equivalent to 21 days effluent production with a maximum depth of 3 metres.

- Add 4.5 kg of urea and 2.5 kg of super phosphate per every 20000 litres of effluent.
- After 21 days, the effluent from anaerobic tank should be allowed to the aerobic tank. The depth of this lagoon should not be more than one metre and capacity should be of 7 days effluent production
- In aerobic lagoon, addition of 450 g of urea and 250 g of super phosphate per 20,000 litres of effluent is essential.
- The effluent coming out of the aerobic lagoon be then stabilized in another tank for one day and used for irrigation if the BOD level is around 100 ppm.

Preparation of cherry coffee is one of the ways of avoiding water pollution. The cherry coffee prepared from mature fruits which are carefully picked and sorted has better quality. Preparations of pulped natural coffee (as in Brazil) also contribute towards avoiding the production of coffee effluent.

10. Opening of Cradle Pits

In sloppy areas cradle pits should be opened across the slope during the post-monsoon period. Cradle pits of 20 inch breadth and 12 inch depth and of convenient length should be opened up in staggered manner in between the rows of coffee all along the contour. Cradle pits act as mini compost pits for the fallen debris, leaves, dadap loppings and weed bio-mass. These pits help in conserving the soil moisture and preventing soil erosion. These pits have to be renovated once in 2-3 years.

11. Hutting

In open patches where adequate shade protection for young seedlings is lacking, the seedlings have to be provided with artificial shade (hutting) with branchlets of jungle trees during the dry months.

For The growers of South-west Monsoon Area

(ROBUSTA)

CULTURAL OPERATIONS TO BE CARRIED OUT DURING DECEMBER-JANUARY MONTHS

1.Nursery
2.Robusta coffee harvesting
3.Coffee Processing
(a) : Preparation of Parchment coffee
(b) : Preparation of Cherry coffee

4.Coffee effluent management
5.Coffee Berry Borer Management
6.Dadap protection
7.Watering of young coffee plants
8.Soil testing and liming of soils
9. Continuation Winter irrigation

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ROBUSTA BEARING PLANT

1.Nursery

Gentle sloping land without big shade trees is preferred for raising nurseries. Water should not stagnate in the nursery sites. Stagnant water near the nursery beds

cause rotting of seedlings. Suitable water resource should be available near the nursery for timely watering of the nursery beds and seedlings. Any shade trees near the nursery will damage the young nursery seedlings in the beds and poly bags due to water dripping from them.

For sowing the coffee seeds, germination beds of 1 metre width and of convenient length raised to a height of 15 cm from the ground level should be prepared. About 4 bags (10Kgs) of matured farm yard manure or compost well dried under sun light be mixed with 2 Kgs of fine Agricultural lime and 0.5 Kgs of Rock Phosphate and thoroughly incorporated in the nursery beds measuring 1X6 metres. In the nursery high clay content should not be used as they restrict the air circulation causing damage to the sprouting seeds. If one is using the clayish soil, then it should be mixed with coarse sand properly to enable easy air circulation. Any deficit air circulation in the nursery soil will cause stunted unhealthy development of the seedlings sometimes resulting in death of the seedlings. The nursery sites should be totally free from nematodes. Therefore, it is advised and recommended that before preparing the nursery, the soils of the nursery site as well as the soils to be used to prepare the nursery beds should be tested in the laboratories for the presence of nematodes. One should note that the compost/farm yard manure used in the nursery should be free from cockchafer pests.

Selected and certified seeds can be sown during December or January in the nursery beds. The seeds be sown with their flat side facing the soil which helps early germination and easy rooting in the soil. After sowing, the seeds are covered with a thin layer of finely sieved soil and mulched with a layer of paddy straw which ensures optimum temperature for seed germination and protects the seeds from desiccation. If paddy straw is not available, any kind of other grass materials can be used for mulching. The beds are then daily optimally watered in the morning hours with rose cans. The seeds will germinate in about 40-45 days and attain button or topee stage. Once this stage is reached the mulch covering the beds should be carefully removed without damaging the germinated seeds. The seedlings at topee or button stage can be then transplanted into either into poly bags or in the secondary nursery beds as the need may be.

2. Robusta coffee harvesting

To maintain and protect the coffee beverage quality, aroma, thickness of the brew, taste and flavour as well as acidity in the cup, the right kind of coffee fruits have to be harvested in right time following certain suggested guidelines. Improper harvesting will result in spoiling the cup quality even if the coffee plants are known to belong to top quality category. Therefore, following the right kind of harvesting procedure will help in protecting the inherent quality as well as helps in getting premium prices.

Coffee fruits have to be picked as and when they become ripe; this can be understood by gently squeezing the fruit with fingers. On gentle squeeze, the bean inside the fruit pops out easily. Under ripe or over ripe fruits should not be mixed or used for the preparation of parchment coffee as they can spoil the overall cup quality. The under ripe coffee fruits result in the production of immature beans and the over ripe ones cause foxy coffee resulting in brown beans with fruity cup. If the harvest is not possible as and when fruits rightly mature, the under ripe and over ripe fruits needs to be separated from the lot and only right kind of desired fruits have to be pulped in the course of preparation of parchment coffee.

The under and over ripe fruits can be converted into cherry coffee. While harvesting the coffee, picking mats should be used, this helps in easy collection of fallen fruits and prevents the mould formation. Prevention of mould formation avoids the production of Ochra Toxin-A in coffee beans. Use of picking mats also reduces the Coffee Berry Borer infection. One should note that, clean gunny bags or plastic bags should be used for collecting the fruits during harvesting. These bags have to be regularly washed with clean water, dried and used for collecting the fruits. Bags used for storing chemicals, fertilizers, pesticides, insecticides and fungicides should never be used for harvesting coffee fruits. No fruits should be allowed to remain in the plants after the end of season harvest as it can invite berry borer infestation.

3. Coffee Processing

(a): Preparation of Robusta Parchment coffee

The pulper, pulper tanks, siphon tanks, rakers, washer, fermentation tanks should be thoroughly cleaned before the pulping operation is undertaken. The premises of the pulper unit as well as the drying yards should be kept in hygienic way. The pulper unit should be properly adjusted depending on the fruit size and checked every day to prevent cuts. Pulper nipped and other deformed beans will yield defective low quality parchment. All the floats, leaves, twigs should be separated from the fruits and only ripen fruits should be fed into the pulper using regulated amount of clean water.

Parchment coffee or plantation coffee can be prepared by pulping, cleanly washed with water and dried under sun. Preparation of such coffee requires pulping equipments and adequate supply of clean water. The quality of parchment coffee is always superior to that of cherry coffee (whole fruit dried under sun). Cherry coffees always give fruity taste as the beans are in contact with the mucilage for a longer time during the course of drying period. Therefore, wet processing of coffee is essential to get superior quality coffee and the method can be followed wherever, all the adequate facilities like sufficient clean water and good processing machineries are available.

The pulping and washing machineries and other equipments used in the preparation of parchment coffee should be cleaned on daily basis. No fruits, fruit skins or beans from the previous day's harvest should be allowed to remain and mix with fresh coffee fruits or pulped beans. These materials badly damage the parchment coffee quality. Only clean water shall be used for processing coffee fruits and all the extraneous matters such as leaves, twigs and stones should be thoroughly removed from the fruits before pulping. If adequate supply of water is not available, then the water used for pulping the fruits can be recycled to pulp the fruits second time. The pulped water however, should not be used on the second day. Further, pulped water should never be used for washing the coffee beans under any circumstances.

As far as possible, harvested fruits have to be pulped on the same day of the harvest. If, it is not possible to process all the fruits on the same day, such fruits can be stored under clean water and pulped on the second day. The fruits stored for more than 10 hours in the open heap without pulping will result in fruity cup. The fruit skins separated by pulping should be taken away from the pulping site as quickly as possible so that microbial decomposition of the skin does not affect the quality of parchment coffee.

The sticky mucilage on the pulped beans can be removed by 4 different methods. However, the commonly followed/adopted methods are two namely: (1) Natural Fermentation and (ii) : Aqua machine wash by friction.

Superior quality coffee can be obtained by natural fermentation method. Fermentation is a critical stage in processing and has a deep influence on the quality of coffee. When pulped coffee is stored in fermentation tanks along with the mucilage, natural hydrolysis of pectins present in coffee mucilage occurs due to the enzymes naturally present in coffee mucilage. In Robusta coffee, natural fermentation will be complete in about 36 to 72 hours due to its thick and hard mucilage. However, this may take longer time also when the ambient temperature is too low. The fermentation process should be controlled so that over fermentation is avoided. Over fermentation will result in foxy beans and make the coffee cup sourish. The under fermented coffee results in imparting mustiness in the cup. The correctness of fermentation can be checked by rubbing the fermenting beans with hand. The mucilage will come off easily and the parchment does not stick to the hand after wash. The beans feel rough and gritty when squeezed by hand and a feeling similar to squeezing pebbles is felt. After the correct fermentation, the beans are cleanly washed 3 to 4 times in clean water or in a washing machine. The quality of the coffee can be further enhanced, if the washed beans are soaked under water for about 6 to 8 hours.

The parchment coffee prepared in such method initially contains around 50 – 55% water content in them. The superficial water content should be removed by spreading the parchment over wire mesh trays and then dried on clean cement or clay lined drying yards till the moisture content reaches a value of 11.0%. Generally parchment takes about 7 – 10 days for drying when spread at a thickness of 5 – 8 cm. If the parchment is spread too thin, rapid drying of coffee at this stage causes the parchment skin to split which lead to cracking of parchment, shrunken and boat shaped beans. Stirring and turning of parchment coffee at least once an hour is essential to facilitate uniform drying. The parchment should be heaped during the evening time and covered with polyethylene/tarpaulin sheets/gunny bags. Drying mass of parchment coffee should never be exposed to mist. Parchment coffee should not be exposed to the hottest sun between noon and early part of the afternoon especially on the 3rd and 4th day of drying. Exposing the parchment to the hottest sun during the 3rd and 4th day will result in wrinkled beans. Once the coffee is dried to a recommended moisture level of 11.0%, the coffee has to be bagged in clean and dry gunny bags. Coffee of different lots should be bagged separately. New gunny bags should be always turned inside out well aerated before use as otherwise the coffee will absorb natural oils and off odours from the bag and give rise to an “acrid” (bitter/pungent/harsh) cup. If the gunny bags are procured from curing works, the bags should be properly fumigated or the curing works should be asked to fumigate and supply to avoid the spread of Coffee berry Borer infestation. Coffee should be stored in well ventilated and dry store rooms. The coffee should be stored on raised wooden platforms to ensure proper circulation of air underneath the bags. Parchment coffee and cherry coffees should not be stored one over the other. The fertilizers, chemicals, oils, insecticides and pesticides should not be stored in the coffee godown.

(b): Preparation of Robusta Cherry coffee

To prepare cherry coffee, fruits should be picked as and when they are ripe. Greens and under ripe fruits should be sorted out and dried separately. All the extraneous matters like twigs and leaves should be separated from the fruits and dried. The fruits should be spread uniformly in the drying yards at a thickness of 7 – 8 cm. Clean cement or clay lined drying yards should be used for drying the cherry coffee.

Use of cow dung smeared or mud drying yards should be avoided. Drying coffee in such yards causes mould formation in cherry coffee and quality of such coffees is very inferior. Coffee should be stirred and ridged at least once every hour to facilitate uniform drying. In the evening time cherry coffee should be heaped and covered with polythene or tarpaulin sheets to avoid contact with the mist. The coffee will be fully dry in about 10 -12 days under the bright weather conditions. Cherry coffee should be dried to a moisture level of 12 to 12.5%. The cherry is dry when handful of the drying cherry produces rattling sound when shaken and a sample forlit records the same weight on two consecutive days. At the end of the harvest, the remaining fruits on the plants should be completely stripped and fallen fruits should be gleaned cleanly. If this method of complete stripping and gleaning is not followed, there is a danger of Coffee Berry borer infestation during the coming years. Stripped and gleaned coffee should be dried separately and should not be mixed with other coffee.

Drying Robusta Cherry

4. Coffee effluent management

Discharging untreated coffee effluent to natural water streams or to open lands is environmentally unsafe as it causes water and land pollution. Use of untreated coffee effluent for irrigation is also prohibited by the law. Since, coffee processing coincides with the dry season when amount of water present in the natural streams is at the minimum, causing further concern of higher degree of pollution.

The coffee effluents emanating from the pulper units are highly acidic and contains high amounts of dissolved and suspended biodegradable organic matters. These effluents, if discharged into natural water bodies without treatment, pollute the receiving bodies by depleting dissolved oxygen present in it. Polluting natural water bodies will have an adverse effect on domestic users, aquatic life, livestock and water course down the stream. The pollution load of coffee effluent is measured in terms of Biological Oxygen Demand (BOD) and Chemical Oxygen demand (COD). Depending on the quantity of water used to process one unit of clean coffee (1 M.T), the BOD and COD amounts vary in the effluent. The amount of BOD range between 10000 and 15,000 ppm in robusta coffee effluent and the COD levels will be around two times of the BOD present in the effluent. One should note that BOD levels will increase if pulped water is recycled during the processing.

In order to protect the environmental health and to control the pollution on account of polluted water reaching the natural water bodies, agricultural land and open spaces, Central Pollution Control Board (CPCB), Government of India has imposed certain laws and guidelines for handling effluents. These guidelines have to be followed mandatorily failing which the person is severely punishable under the law. As per the CPCB statute, the water to be used for irrigation should not contain more than 100 ppm of BOD and water to be discharged to natural water bodies should not contain more than 30 ppm of BOD. Since, coffee effluent contains more than the stipulated levels of BOD and COD, it has to be treated by following recommended methods of treatment before use in the field or discharging it to the streams.

Steps to be followed in the treatment of Coffee Effluent

- All the fruit skin shall be cleanly separated from the pulped water using suitable screens
- The coffee effluent coming out of the washer unit should be stored in a lagoon for one day. The capacity of this lagoon shall be of one day's water use capacity of the processing unit.
- This effluent should be neutralized with appropriate amount of Agricultural lime so that the pH of the effluent is around 6.9 to 7.0. Generally 5 grams of good liming material is adequate to neutralize 0ne litre of the effluent.
- After one day of storage, the effluent is allowed to the anaerobic lagoon. Before allowing the effluent to the lagoon, the anaerobic lagoon should be charged with 4% cow dung slurry up to 10% of the capacity of the lagoon. Charging of the anaerobic lagoon should be done one month before the pulping operation starts so that the methogenic bacteria present in the cow dung slurry which are responsible for the degradation of the biological materials get stabilized. The capacity of the anaerobic lagoon should be equivalent to 21 days effluent production with a maximum depth of 3 metres.
- Add 4.5 kg of urea and 2.5 kg of super phosphate per every 20000 litres of effluent.
- After 21 days, the effluent from anaerobic tank should be allowed to the aerobic tank. The depth of this lagoon should not be more than one metre and capacity should be of 7 days effluent production
- In aerobic lagoon, addition of 450 g of urea and 250 g of super phosphate per 20,000 litres of effluent is essential.

- The effluent coming out of the aerobic lagoon be then stabilized in another tank for one day and used for irrigation if the BOD level is around 100 ppm.

Preparation of cherry coffee is one of the ways of avoiding water pollution. The cherry coffee prepared from mature fruits which are carefully picked and sorted has better quality. Preparations of pulped natural coffee (as in Brazil) also contribute towards avoiding the production of coffee effluent.

5. Coffee Berry Borer Management

The recommended phyto-sanitary methods have to be cleanly followed in the estate adopting cultural and mechanical operations.

- Broca traps have to be installed in the estate as well as near the drying yards
- Picking mats should be used during the harvesting. Use of picking mats facilitates the easy collection of fallen berries and avoids the berries coming into contact with the soils thereby preventing the possible mould formation.
- All the left over berries on the plants and gleanings should be cleanly picked
- If the berries are partially damaged by Coffee Berry Borer, such berries can be immersed in boiling water for 1 minute and then dried.
- Highly damaged berries should be destroyed by burning
- Coffee should be dried to the recommended moisture level.
- Care should be taken not to transport coffee from the CBB infested area to the non-infested areas.
- While procuring gunny bags from the coffee curing works, they should be properly fumigated to avoid the entry of CBB into your estate. The growers shall demand fumigation of gunny bags by the coffee curers. Always use clean and as far as possible new gunny bags.

6. Dadap protection

Protect the young dadap plants (during the first 2 years after planting) from scorching sun by treating (brushing or spraying) the stems with 10% lime solution (10.0 Kgs of spray lime in 100 litres of water).

7. Watering young coffee plants

After the monsoon, it is recommended that young coffee plants should be watered with 5 to 10 litres water per plant once in a week. This avoids the wilting and death of young plants and facilitates easy and faster rooting of the plants. The growth of watered plants will be better and plants grow healthily. When the moisture content of the soil comes down in watered plants area, again the plants need to be watered so that wilting of the plants can be prevented. It should be noted that weed germination is faster in the watered region and regularly they should be slash weeded. Water requirement is generally higher (evaporation rate is

more) wherever, shade density is low and in such places mulching of young plants is necessary.

8. Soil testing and liming of soils

Liming of Soils

In order to grow healthy coffee plants and to realize better crop, it is very important to protect primarily the soil health. The various plant nutrients in the soil need to be maintained in balance so that the soils remain productive for a long time. The acidity (pH) determines the productivity of the soil and nutrient assimilation/mineralization in the soil. In order to have better fertilize use efficiency of the applied fertilizers, the soil pH should be maintained at around 6.1 in coffee soils. Due to the continuous application of acid causing fertilizers like ammonium sulphate, ammonium chloride and DAP and due to the leaching of calcium and magnesium elements in the soil, the soils tend to become acidic. Therefore, to monitor the soil pH, soils have to be tested compulsorily once in 2-3 years. When the soil pH goes above 6.2 or comes below 6.1, the soil pH needs to be corrected because the availability of essential plant nutrients depends on the soil pH. Strongly acidic soils (pH below 4.5) are relatively poor in productivity because of essential plant nutrient deficiencies or toxicities of essential or non essential elements. Highly acidic soils are harmful for the useful soil micro-organism and in such soils coffee plant growth is always tend to be stunted in nature. If the soils are alkaline (above pH 7.0), most of the essential plant nutrients are not available to the plants.

Whenever, the coffee soil pH falls below 6.1, the soil pH should be corrected by the application of alkali forming soil amendments like agricultural lime(Calcium Carbonate), dolomite (Calcium and Magnesium Carbonates). Liming of the coffee soils can be done anytime of the year except during monsoon period. However, keeping in mind the coffee zones, it is known that November to February months are the ideal period for lime application. One should take care that adequate moisture is present in the soil for the best use of applied lime. Liming materials has to be uniformly broadcasted in the field. Finer the liming material, higher will be its efficiency and the soil pH gets corrected faster. Liming of the soil should be done only after soil test and the quantity of the liming material accordingly decided.

If the recommended dose of liming material is more than 3.5 metric tonnes per hectare, in such case the dose has to be split into two equal parts and applied in 2 years. The scientific use of lime on acid soils can appreciably improve the soil productivity and the plant uptake of nitrogen, phosphorus, potassium and micro nutrients. In the case of soil pH going beyond 6.2, then pH can be corrected by the application of acid forming fertilizers. It is recommended that each lime samples should be tested for purity before use in the field. This will help in deciding the correct quantity of the procured lime to be applied in the field based on its purity.

Soil Sampling

It is important that the soil samples collected should be the representative of the field to be tested. The important procedure to be followed for the best sample collection is as follows.

- The field has to be divided into blocks of 2 hectares each. Sample each block separately.
- When the areas within the field differ distinctly in growth of plants or appearance of the soils or known to have been treated differently, soil samples in such blocks should be collected and labelled separately.
- Do not collect the sample during rainy season. Do not send the soil samples for analysis which are collected long back and stored.
- Select at random 20 spots in each block, remove surface litter and dig a hole of 9 inches diameter using a suitable tool up to 9 inches depth. Scratch the soil samples uniformly round the hole from top to bottom and collect 1 kg of the sample and mix well to get the composite sample..
- Samples should not be collected from the blocks which are recently limed or fertilized. Do not collect samples from road side, old bunds, and marshy places or near the shade trees. Collect soil samples at the centre of 4 coffee plants.
- Dry the samples under shade and pack in a polyethylene bags or cotton bags and send to the laboratory properly labelled. Do not use fertilizer contaminated bags.
- Give the details of the estate, crop harvested for the last 5 years, elevation, rainfall details, irrigation schedules if any, variety of coffee and age of the bushes.

9. Continuation Winter irrigation

Robusta coffee is susceptible to drought and responds well to irrigation. First, winter irrigation needs to be commenced 20-25 days after the cessation of monsoon. Irrigation of 25mm is to be given once in 20-25 days till the end of December. In case of rain during this period, then irrigation should be given only after monitoring the soil moisture.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING FEBRUARY-MARCH MONTHS

1. **Fire Path**
2. **Continuation of Harvesting and Processing**
3. **Gleaning**
4. **Soil Testing and Liming**
5. **Leaf Analysis**
6. **CBB management**
7. **Pruning**
8. **Blossom irrigation and Backing**
9. **Compost Preparation**
10. **Nursery**
11. **Stripping**

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1. Fire path

During the summer period there is a chance of wild forest fire occurring in the nearby forest or in the vicinity of the coffee estate. Hence as a precaution, fire paths have to be created round the estate by clearing all the dried leaves, dead tree remains, branches etc in order to avoid the fire spreading to the estate.

2. Continuation of Harvesting and Processing

The harvesting can be continued as explained earlier in the month of December and January.

3. Gleaning

During the harvest some amounts of berries fall on the ground. At the end of complete harvest and stripping, such fallen berries should be collected neatly and completely. They should be dried separately and should not be mixed with other coffee. Coffee obtained from gleanings will have earthy taste and possibility of mould contamination is likely in such coffees. By neat gleaning, infestation of CBB can also be avoided.

4. Soil Testing and Liming

If the soil analysis is not done during the previous months, soil testing has to be done and required amount of liming material has to be broadcast in the field. The liming material should be tested for its purity prior to its use.

5. Leaf analysis

Coffee leaf analysis offers another type of approach in determining the nutrient availability of a soil and actual nutrient status in the plant itself. In order to determine the exact nutrient status in coffee plant, leaf analysis is very essential and a

useful tool. The status of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and other micro-nutrients can be exactly determined by chemical analysis of the leaves and deficiency of any of the essential nutrient element can be identified to take appropriate step in time before it becomes a limiting factor in productivity of the plant. Simultaneous analysis of soil and complimentary leaf samples gives precise requirement of nutrients and helps in enhancing the accuracy of fertilizer recommendation services since these analyses are complimentary to each other.

The leaf analysis can be done ideally during February-March and September-November months. Third pair of leaves from growing tip of Robusta plant branches from the 2/3 height of the over all plant has to be collected randomly from the field. A minimum of 25 pairs of leaves from one hectare land is necessary for precise analysis. The leaf samples should be collected only during the morning time preferably before 10.00 a.m and placed between two sheets of blotting paper and packed in a perforated polythene bags and sent to the laboratory immediately. The details on the block history, age of the plant, fertilizers applied and crop harvested should be sent to the laboratory while sending the leaf samples. These samples are then washed with clean water and dilute hydrochloric acid to remove any superficial chemicals, dust and spray particles adhering to the leaf surfaces before processing for chemical analysis.

6. CBB management

All the left over berries on the plants have to be cleanly collected and install broca traps in the field. Follow other recommended phyto-sanitary control measures.

COFFEE BERRY BORER BORING THE COFFEE BERRY

7. Pruning

Pruning is an important cultural operation in coffee estates. Pruning of plants reduces the greater risk of biennial bearing habits of the plants and helps in harvesting average crop each year. Pruning helps in reducing the exhaustion in plants and increases the fertilizer use efficiency by the plants. Other advantages of pruning are that all the plant parts get good aeration and light and helps in reducing the pest and disease incidence level.

In Robusta plantations, pruning is done immediately after the harvest. But is strongly suggested that pruning operation should be started after observing the environmental situations like there should be sufficient soil moisture and weather

condition should not be dry. Lack of soil moisture and dry conditions introduce further strain on the plants if the pruning is done under this condition resulting in poor development of branches. Therefore, pruning can be best done after the receipt of a minimum of 2 inches rain. After few summer showers, plants put forth new shoots and this is the best time to start pruning. However, in irrigated, blocks, pruning can be done immediately after the harvest. Remove all the criss -cross branches, whippy wood, exhausted wood and diseased branches.

8. Blossom irrigation and Backing

Generally between February 15th and March 15th flower buds will mature and will be ready for blooming in Robusta coffee. Robusta coffee responds very well for sprinkler irrigation. Sprinkler irrigation can be practiced when there is a failure of blossom and backing showers. In Robusta, if blossom shower is not received in time or in deficient quantity, then flower buds turn pinkish and fall. Hence, if such conditions are seen, then immediate supplementary sprinkler irrigation can overcome this damage. After 15 to 20 days of the blossom, sprinkler irrigation should be given if backing showers are not received within this period. Use of rain guns for sprinkler irrigation will reduce the time of irrigation and save water.

For healthy blossom, one should give a minimum of 25mm water. Similarly, one inch of water is required for backing. In irrigated plots, fertilizers can be applied on the next day or one day prior to irrigation. If the fertilizer applications are done prior to irrigation, all the fertilizer granules shall be properly mulched before irrigation.

It should be noted that Robusta is a very sensitive plants and easily responds to rain. It requires timely blossom and backing shower. If, Robusta coffee plants do not receive blossom shower by March 15th, this will affect the bearing crop and there will be a considerable loss of crop every week. Therefore, Robusta coffee should be grown in areas where there is adequate resource for irrigation. In the case of blossom and backing shower failure this will come handy for irrigation and protect the crop.

SPRINKLER IRRIGATION

9. Compost Preparation

Shade tree leaf litter, weeded materials, fallen twigs, green leaves, coffee skin, cherry and parchment husk are the raw materials for the preparation of compost in the estate level. In addition to these, coir pith, cow dung and domestic wastes can also be used for the preparation of compost depending on their availability in the farm level. The coffee effluent can be used for moistening the compost pits as well as to enrich the quality of the compost. Earth worms can be used to degrade the coffee processing wastes mixed with cow dung and domestic wastes. The compost should be applied to the fields preferably during the post monsoon period for better efficiency. If compost is applied during the summer months, the mineralization of the compost will be slow and chances of losing the mineral content are more during the dry season.

COMPOST HEAPS

10.Nursery

For basket nursery one should use the polythene bags of the dimension 6 X 9 (b X h) inches of 150 gauges. If lower gauge bags are used, there is a chance that the bags may break when soil is filled. Use of lower dimension backs severely hinders the healthy development of roots. Further, 12 uniform holes (3 mm) at equidistance should be made on the nursery bags to facilitate easy air circulation for the growing seedlings as well as to allow the excess water to flow out. Stagnation of water in the bags results in the rotting of seedlings.

A nursery mixture of 6 parts of sieved jungle soil(free from nematodes and other pests), two parts of well rotted cattle manure or compost and one part of coarse river sand (do not use sea sand as it contains sodium which is harmful to the seedlings) should be prepared and mixed well to fill the nursery bags. If the jungle soils are not available, it can be substituted with sieved surface soil mixed with compost or vermin compost. Prior to planting, the nursery bags should be gently watered and a vertical hole of about 5 cm deep should be made in the soil at the centre of the bags. The coffee seedlings at button stage are transplanted into the nursery bags. Seedlings should not be planted deep in the nursery bags and after planting, the seedlings should be watered daily in the morning times. Nursery should be cleaned off from weeds and

ROBUSTA NURSERY

other plants regularly. Provide overhead pendal shade till the commencement of regular monsoon.

There is a possibility of Cercospora (Brown-eye- spot) disease infecting the tender leaves of the seedlings in the nursery. To prevent the disease, spray Indofil -M-45 solutions (5 g/1 litre of water) or Bavistin (1g/litre)

Now a days, another fungal disease is also seen in the nursery this is caused by a fungus called *Myrothecium roridum*. In the case of attack the nursery plants show infection of the stem portion and leaves. The symptoms observed are water soaked brown to greyish white discolouration followed by defoliation of the leaves and death of the seedlings. To prevent and cure this disease, spray 0.8ml of Tilt (propiconazole) in one litre of water. This spray should be done once in a month till the end of the monsoon. In case of earthworm problem in the nursery and nursery baskets, this can be prevented by pouring soap nut solution. The solution can be prepared by finely crushing fresh soap nuts and squeezing them in water.

Before transplanting the seedlings in the field, remove and destroy all the suspicious, stunted and disease affected seedlings from the nursery and plant only vigorous and healthy seedlings to avoid any future problems in the field.

11. Stripping of the crop

At the end of harvest, the berries remaining on the coffee plants have to be stripped off completely. This operation should be done carefully without harming or damaging the plant branches or new flower bud bearing branches. If the new shoots and branches are damaged, it will affect the next year crop. The one of the advantages of complete harvest is to reduce and avoid berry borer infestation during the coming years. Stripped berries should be dried separately and should not be mixed with other coffee as the quality of such coffee is inferior.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING APRIL-MAY MONTHS

1. **Line Marking**
2. **Pitting**
3. **Pruning**
4. **Pre-monsoon Manuring**
5. **Shade regulation**
6. **Opening of Cradle pits/drainage**
7. **Coffee Berry Borer Management**
8. **Clonal Propagation of Plants**

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1. Line Marking

While choosing the site for coffee planting due consideration should be given to elevation, slope, aspect, soil type, rainfall, wind speed, shade trees, and availability of perennial water source and transport facilities. North, East and North-East aspects are suitable for growing coffee. Western aspect is not suitable because plants suffer from scorching sun. If one wants establish plantations in lands facing Western aspect, then proper thick shade cover has to be provided to protect plants from direct sunlight. Before new planting, shade trees have to be planted in adequate numbers in advance to give protection to the young plants. If, already the land is covered with trees, then while regulating the plant density, selective retention of desired species should be done.

The planting land should be divided into blocks of convenient size with proper foot paths and roads for transportation laid out in between. Dadap plants have to be planted in the blocks at a distance of 20 feet apart during June month to provide temporary lower canopy shade. Within each block, the points for planting coffee seedlings should be located by marking the distance between the rows and plant distance. The following are the optimum spacing for different coffee cultivars:

(a) Tall Robusta – 10 X 10 feet
(c) C X R - 8 X 8 or 9 X 9 feet

Once the land is marked, the soils from each block have to be tested and required amount of agricultural lime should be applied to correct the soil pH for the optimum growth of the plants. In steep slopes it is suggested to adopt contour planting so that soil erosion can be prevented and this method also helps in easy operation of the cultural practices. Square system should be adopted in gentle or flat lands.

2. Pitting

Pits for coffee planting are to be opened after few summer showers during March month. If, summer showers are delayed, this work can be deferred till the showers are received. The pits measuring 1.5 X 1.5 X 1.5 feet length, breadth and depth are ideal for planting. After opening, pits are to be exposed for weathering for 15 – 20 days. Later, add 1.0 – 1.5 kgs of compost/farm yard manure and 50-100 gms

of rock phosphate in each pit and close the pits by filling in with the surrounding top soil. A small bamboo stick or wooden pole can be inserted at the centre of the pit for identification.

3. Pruning

When one or two summer showers are received, coffee plants start producing new shoots. This is the right time for pruning. Pruning essentially a thinning process to direct the vigour of the plants into those parts which produce crops. Pruning is to remove the unproductive wood for encouraging the growth of new branches which would become next years cropping wood. Pruning facilitates the entry of adequate sun light and air to all parts of the bushes thereby reducing the incidence of pest and diseases and helps maintaining the frame work of the plants in desired shape.

In some plantations, there is a practice of pruning the coffee plants immediately after the harvest. But pruning operation should not be started until one or two summer showers (minimum of 2 inches of rain) are received. If sufficient moisture is present in the soil after the harvest, then pruning can be done immediately. In irrigated blocks pruning can be done immediate after the harvest. The plants generally under stress due to mechanical injuries caused during the harvest. Under this condition if pruning is done in the absence of soil moisture, the plants suffer further stress because of the pruning operation resulting in poor future development of cropping woods. Precaution should be taken not to prune deeply exhausted or diseased or die –back affected plants until sufficient rain is received as indicated above. It is recommended to practice only light pruning involving removal of old unproductive wood, criss-cross branches, branches touching ground, lean, lanky and whippy wood and pest and disease affected branches as well as branches growing towards main stem and ground. Use only sharp tools to prune the plants

4. Pre-monsoon Manuring

After the harvest and pruning, coffee plants will be generally in an exhausted and weak condition. Once the summer shower is received, we can see immediate growth activities in the plants and they start to produce new shoots. During this phase, it is essential to supply plant nutrients in required quantities through soil application of fertilizers.

In every coffee estate, the grown up plants need 50:50:50 kgs of nitrogen, phosphorus and potash per hectare for their vegetative growth. This is called sustenance nutrient dose which has to be given compulsorily to keep the plant health in good condition. The sustenance dose of fertilizer does not depend on the level of crop harvested or in the bearing but needed for the proper growth of roots, stem and vegetative parts.

The remaining quantity of annual fertilizer requirement of coffee plants are calculated based on the age and health of the plants, soil test values and crop level as well as the average crop harvested during the last five years. Therefore it is essential that the soils have to be tested for their fertility status routinely in order to avoid under or over fertilization in the field. The calculated amounts of fertilizers need to be applied in 2 to 3 splits. One of the split doses of fertilizer has to be given during the pre-monsoon period i.e. after receiving sufficient amounts of summer shower.

Before the application of pre-monsoon fertilizers, the plants should be relieved of their unproductive and undesired growths (pruning) and should complete weeding

operation. Based on the recommended levels of fertilizers and area to be fertilized, suitable quantity of fertilizers should be uniformly mixed and applied in the field.

The maximum fertilizer use efficiency will be obtained when they are placed around the plant instead of broadcasting. Therefore, all the mulch shall be cleared around the plant up to the plant canopy area leaving one foot distance from the main stem. The soil in this area is then slightly disturbed using the forks and fertilizers should be uniformly applied in this area. After the application, the soil has to be reworked so that all the fertilizer particles are well covered and finally re-mulch the soil with the previously cleared mulch. One should note that a single split dose of fertilizer should not exceed 100:75:100 kgs of N: P: K per hectare. If larger quantity of fertilizers is given in a single split there is a high chance of loss of nutrients due to volatilization. In highly productive blocks, the number of split doses will be more than 3-4 splits. The plants during the blossom/after blossom and pre-monsoon period essentially require phosphorus nutrient and hence, one should not skip phosphorus application during this period. It is advised that all the farm wastes like fruit skin, mucilage and cherry or parchment husks shall be composted in the estate and recycled in the farm.

5. Shade regulation

Coffee requires optimum filtered shade for its best performance under Indian conditions. Therefore it is essential to regulate the shade trees regularly in order to provide required light intensity to the coffee plants. Generally May is the ideal month for shade regulation. Shade regulation should not be undertaken if dry weather and lack of moisture in the soil prevails in the field. Shade regulation under this condition further increases the soil moisture loss leading to wilting of plants and decreased new shoot formation which will adversely affects the next year crop. The white stem borer activities can also increase leading to higher infestation on coffee plants. Therefore, shade regulation shall be done preferably only after receiving 4-5 inches of rainfall. Meticulously and properly regulated shade helps in minimizing the biennial bearing habits of coffee plants, avoids die-back and wilting of plants. All the drooping branches of shade trees at a height of 9-12 metres above the coffee plants should be removed so that filtered light penetrates into the ground.

Similarly, the lower tier shade (dadap) should also be regulated. As soon as monsoon sets in, the branches of all the dadap plants should be removed. The lopped small branches shall be finely chopped and all the leaf compliments obtained during the shade regulations shall be spread all over the ground and allowed for rotting. After the monsoon, dadap plants needs to be regulated depending on the growth of dadap plants. The dadap stakes can be used for planting in other areas.

6. Cradle pit/ Drainage Channels

In slopy areas, the cradle pits are generally opened during October-November months. These pits get filled during the north-east and S-W monsoon period and hence needs renovation once in 2-3 years. All the deposits like washed soil, leaf litter, weed bio-mass and tree debris shall be removed from these pits and spread near the surrounding plants. April-May months are the ideal period for the renovation of these pits. Similarly, before the onset of the monsoon all the drainage channels should be cleaned and connected to the main catch pits. If these channels are not renovated, water will stagnate in these channels and pits which causes damage to the coffee plant

roots due to chilling effect causing wet feet disorder in plants. Wet feet disorder causes defoliation in plants. In water logging areas (flat areas), drainage channels of 1.5 feet breadth and 1 foot deep should be opened up at suitable distances between the rows to drain out excess water from the field. These drainage channels should be connected to the water catch pits opened at the end of the field. Proper drainage system provided in the coffee fields helps in improving the soil structure, root respiration and development. Collecting excess water in catch pits increases the water table in the ground.

7. Coffee Berry Borer Management

Remove all the left over berries on the plants. Install broca traps in the field

8. Clonal Propagation of Plants

Coffee can be propagated successfully using the vegetative parts of the plants like shoots, leaf and suckers. This technique offers an advantage of preserving the unique desired characteristics of any individual plant in its offspring. Vegetatively, coffee can be propagated by cutting as well as by grafting techniques.

Propagation through cuttings:

Select 3-6 month old (pencil thick) orthotropic suckers from healthy productive selected plants. Do not select plageotropic (horizontal) suckers for vegetative propagation as they always maintain lateral growth. From each selected sucker, prepare as many as single node cuttings as possible of 10 cm length with a basal slant cut and top horizontal cut at inter-nodal region by retaining a pair of leaves in each node. Cut the leaves to half of their size. Immerse the cuttings for about a minute in a bucket containing Bavistin solution (1 gm of Bavistin in 250 ml water) to avoid any fungal contamination. Dip the base of the cutting (slant cut) for 5-10 seconds in Indole butric acid solution (500 mg of indole butric acid + 50 ml alcohol and 100 ml water) for facilitating early rooting. These cuttings can be planted in punched polythene bags of 9 X 6 inch size filled with soil mixture. The soil mixture has to be prepared by mixing well sieved jungle soil, sand and farm yard manure in the ratio 6:3:1. These bags have to be arranged in propagation trenches. The propagation trenches are of 1 metre width, 0.5 metre depth and 2.5metre length covered with polythene transparent sheets of 500 gauge over a supporting frame made of either bamboo or metals. The trenches with the planted cuttings have to be provided with overhead coir mat or agro-net shade. Narrow drainage channels have to be made around the trenches to drain off rain water. Watering of the cuttings should be done once a day during the morning hours in cool season. During the dry season watering should be done two times, once in the morning and second time in the afternoon. Cuttings will root in about 3 months after transplanting under trench condition. After rooting, the cuttings are to be hardened for two months under coir mat shade. The hardened rooted cuttings can be planted in the field. Planting of these cuttings during June-August gives good establishment of the plant.

Note: Training on vegetative propagation will be given at Central coffee Research Institute for the interested growers.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING JUNE-JULY MONTHS

1. **Planting Shade trees**
2. **Desuckering/Handling**
3. **Weeding**
4. **Nursery**
5. **Coffee Berry Borer Management**

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1. Planting Shade trees

June-July months are ideal for planting shade trees. It is always better to have mixed shade trees rather than having mono shade like silver. Planting only silver oak trees does not ensure filtered shade. The temperature of the field is generally higher in the estates where silver oaks are planted as shade trees. Further, the silver oak leaf litter does not degrade as quickly as other leaves. The black rot disease and white stem borer incidence are more prevalent in estates with silver oak as shade tree. Therefore, it recommended that in coffee estates more of other shade trees have to be planted like *Indian fig, atti, bili basari, mallegargatti, rose wood, jack, gandagarige* and trees belonging to leguminous family. In high rainfall areas, the plants which shed leaves during the monsoon but quickly foliate after the monsoon have to be chosen. The trees like A*tti or Balanji* belong to this category. Planting of trees like *neeli* in the estates should be avoided as these trees harbour caterpillars. Permanent shade trees should be planted at a distance of 12-15 metres. In wind prone areas, silver oak and silk cotton trees have to be planted densely round the boundary of the estate.

2. Desuckering/Handling

Plants start producing more new shoots after the receipt of sufficient showers. This necessitates one or two rounds of handling once during June-July months and later during August-September. During the handling operation, the new flush arising after the main pruning is thinned out to a desired number (2 per node) of well spaced branches.

Centring should be done by the removal of new shoots arising within half foot radius of the main stem. This facilitates good air circulation and penetration of light into all parts of the plant as well as prevents the black rot disease. Centring is a skilled work; too much opening of the centre of the plants may invite trouble from White Stem Borer. Desuckering has to be done by removing the suckers growing from the main stem. Gourmandizers should not be retained. There is a practice in some estates allowing the gourmandizers for many years. This practice should be discontinued as it spoils the plant frame work and all the lower branches will be affected in due course. All the criss-cross branches should also be removed. By removing all such undesired growth, the fertilizer use efficiency by the plants can be increased.

3. Weeding

Weeding operation has to be undertaken. Use slash weeding

SLASH WEEDING

4. Nursery

Remove the overhead pendal from the nursery completely. Provide proper drainage channels round the nursery to avoid water stagnation. Nursery should be cleaned of from any weeds.

5. Coffee Berry Borer Management

The coffee berry borer incidence in the estate should be monitored and should take all the preventive measures. Use *Baveria bassiana* fungus culture solution to control the CBB. (See Arabica section for details)

CULTURAL OPERATIONS TO BE CARRIED OUT DURING AUGUST-SEPTEMBER MONTHS

1. **Planting and Gap filling**
2. **Mid monsoon manuring**
3. **Coffee Berry Borer Management**
4. **Indenting for Seed coffee**

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1. Planting and Gap filling

6-8 month old basket seedlings can be planted in the field. Gap filling should be done with the same variety. Do not practice planting different varieties of coffee in the same block. Different varieties perform differently in the same block in terms of growth, quality and productivity. Therefore, planting different varieties in the same block will disturb the field uniformity as well as results in inconsistent cup quality. Further, the level of disease and pest resistance of different varieties is different from each other.

Provide adequate protection to the plants from cattles and monkey menace. Protect the plants from cockchafer pest during the initial years of planting. Keep the weeds away from the new planting site as they compete for applied fertilizers with the coffee plants. Weeds are more efficient than coffee plants in absorbing applied nutrients and hence keep them away. Mulch every new coffee plant and provide them protection from wind by placing cross stakes. Wherever, shade protection is deficient, hutting should be done.

2. Mid- monsoon manuring

During the monsoon, nutrient nitrogen is lost very fast due to leaching. Plants need nitrogen during this period in order to produce more of shoots and branches. It is necessary to provide nitrogen to the plants to balance the nitrogen loss due to leaching. Therefore, apply 58 kgs of nitrogen (2.5 bags of Urea) per hectare during the break in the monsoon. This mid monsoon application of urea also helps in reducing the berry drop.

3. Coffee Berry Borer Management

The coffee berry borer incidence in the estate should be monitored and should take all the preventive measures. Use *Baveria bassiana* fungus culture solution to control the CBB. (See Arabica section for details)

4. Indenting for Seed coffee

Robusta/C X R seed coffee for the preparation of nursery should be procured only from the Central Coffee Research Institute and its other Sub and Regional stations and through Extension wing of the Board. Growers are advised to book their seeds by advance payment either at CCRI or with the extension offices not later than September.

CULTURAL OPERATIONS TO BE CARRIED OUT DURING OCTOBER- NOVEMBER MONTHS

1. **Weeding**
2. **Soil digging**
3. **Post monsoon Manuring**
4. **Soil testing and Liming**
5. **Hutting**
6. **CBB management**
7. **Winter Irrigation**

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1. Weeding

Different types of weeds grow in coffee estates and they compete with coffee plants for moisture and mineral nutrients. If the weeds are allowed to grow during the late post-monsoon period, they use the soil moisture which coffee plants need in the following dry season. Free growth of weeds reduces the yield of coffee plants as well as their growth. Therefore, it very important to control the weeds in the field. In young plantations weeds are the major problems during the initial years. In new clearings, the weeds should be removed by slash weeding at least 3-4 times in a year. While in established fields, 2-3 times this operation has to be carried out. All the slashed weeds should be spread in the field during the rainy season for rotting and bio-degradation. Weeds which have the habit of flowering should be removed before they flower. After the monsoon, clean weeding should be done in the entire estate.

In established plantations, recommended weedicides can also be used. But one should note that, the sprayers used for spraying weedicides should never be used for spraying any other chemicals without ensuring 100% cleaning. Use WFN 062 or WFN 040 flood jet nozzles for spraying weedicides. The use of weedicides should be judicious and as far as possible the use should be restricted to the most minimum level to avoid environmental contamination. Weedicides along with wetting agent should be applied on a bright sunny day when there is sufficient moisture. The soil moisture helps the faster absorption of the weedicides by the weeds.

In the new clearing, the fields should be given a thorough cover digging to a depth of 9 inches towards the end of monsoon and all weeds, vegetative wastes and debris should be completely turned over and buried into the soil. In young clearings, coffee planted at normal spacing covers only a small portion of the ground and therefore weeds grow prolifically. In such spaces growing of green manure crops, cover crops, legumes, beans, pigeon peas, sweet potato and vegetables are recommended as these plants hinder the growth of weeds. The crop from these plants can either be harvested or these plants can be cut and incorporated in the soil again. In 2-4 year old plantations, the soil has to be scuffled to a depth of 0.25 inches (7.5 cm) or cover crops have to be grown.

Recommended Weedicides

Paraquat-di-chloride 24% EC @ 0.067% active ingredient (a.i.)
For example dissolve 500 ml of Gramoxone in a barrel of water and spray.

Or

Glyphosate 41% EC @ 0.27% a.i.
For example dissolve 1200 ml of Round up or Glycel in a barrel of water and spray.

The cost and the quantity of the weedicides can be brought down by nearly 50% by the addition of 2 kgs of Urea to the spray solution without affecting the efficiency of the spray solution. By adding 2 kgs of urea, the dosage of Gramoxon could be reduced to 250 ml while the quantity of Round up/Glycel could be reduced to 600 ml per barrel.

2. Soil digging

After one year of planting, soil digging should be given to a depth of 9 inches in new clearing towards the end of monsoon. All the weeds should be completely turned under and incorporated in the soil thoroughly. This operation shall be done only for two years after planting coffee. This will help in suppression of weed growth and conservation of soil moisture in new clearings. Avoid deep digging in steep slopes as it can lead to soil erosion. If the plants are 3-4 years, then soil scuffling can be done to a depth of 3 inches.

3. Post monsoon Manuring

Nitrogen is the most important plant nutrient and plants need it throughout the year. Nitrogen helps in the development of new shoots and berries. Nitrogen also helps in the production of large number of flowers and retention of leaves for a longer time. Adequately nitrogen supplied plants produce dense beans of higher quality.

Potassium is another element which is essential for the fruit setting, bean filling, maturation and hardening of the beans. It improves the vigour and the pest and disease tolerance of the plants. Phosphorus is needed for the healthy and strong development of roots and shoots.

After the monsoon, recommended doses of fertilizers have to be applied. Though the placement of fertilizers (pegging) is very efficient in terms of utilization, the process is laborious and time consuming. Therefore, simple method of application is suggested as under. Remove, the mulch under the plant canopy leaving one foot circle around the main stem. Slightly disturb the soil in the de-mulched area with forks. Broadcast fertilizer uniformly and evenly in this area and rework the soil. Cover again with the removed mulch. This method is very efficient and it avoids volatilization and washing away of nutrients. In steep areas, fertilizers can be applied in semi arch form on the upper side of the stem down the slope.

4. Soil testing and Liming

In order to grow healthy coffee plants and to realize better crop, it is very important to protect primarily the soil health. The various plant nutrients in the soil need to be maintained in balance so that the soils remain productive for a long time. The acidity (pH) determines the productivity of the soil and nutrient assimilation/mineralization in the soil. In order to have better fertilize use efficiency of the applied fertilizers, the soil pH should be maintained at around 6.1 in coffee soils. Due to the continuous application of acid causing fertilizers like ammonium sulphate, ammonium chloride and DAP and due to the leaching of calcium and magnesium elements in the soil, the soils tend to become acidic. Therefore, to monitor the soil pH, soils have to be tested compulsorily once in 2-3 years. When the soil pH goes above 6.2 or comes below 6.1, the soil pH needs to be corrected because the availability of essential plant nutrients depends on the soil pH. Strongly acidic soils (pH below 4.5) are relatively poor in productivity because of essential plant nutrient deficiencies or toxicities of essential or non essential elements. Highly acidic soils are

harmful for the useful soil micro-organism and in such soils coffee plant growth is always tend to be stunted in nature. If the soils are alkaline (above pH 7.0), most of the essential plant nutrients are not available to the plants.

Whenever, the coffee soil pH falls below 6.1, the soil pH should be corrected by the application of alkali forming soil amendments like agricultural lime(Calcium Carbonate), dolomite (Calcium and Magnesium Carbonates). Liming of the coffee soils can be done anytime of the year except during monsoon period. However, keeping in mind the coffee zones, it is known that November to February months are the ideal period for lime application. One should take care that adequate moisture is present in the soil for the best use of applied lime. Liming materials has to be uniformly broadcasted in the field. Finer the liming material, higher will be its efficiency and the soil pH gets corrected faster. Liming of the soil should be done only after soil test and the quantity of the liming material accordingly decided.

If the recommended dose of liming material is more than 3.5 metric tonnes per hectare, in such case the dose has to be split into two equal parts and applied in 2 years. The scientific use of lime on acid soils can appreciably improve the soil productivity and the plant uptake of nitrogen, phosphorus, potassium and micro nutrients. In the case of soil pH going beyond 6.2, then pH can be corrected by the application of acid forming fertilizers. It is recommended that each lime samples should be tested for purity before use in the field. This will help in deciding the correct quantity of the procured lime to be applied in the field based on its purity.

Method of Soil Sampling

It is important that the soil samples collected should be the representative of the field to be tested. The important procedure to be followed for the best sample collection is as follows.

- The field has to be divided into blocks of 2 hectares each. Sample each block separately.
- When the areas within the field differ distinctly in growth of plants or appearance of the soils or known to have been treated differently, soil samples in such blocks should be collected and labelled separately.
- Do not collect the sample during rainy season. Do not send the soil samples for analysis which are collected long back and stored.
- Select at random 20 spots in each block, remove surface litter and dig a hole of 9 inches diameter using a suitable tool up to 9 inches depth. Scratch the soil samples uniformly round the hole from top to bottom and collect 1 kg of the sample and mix well to get the composite sample..
- Samples should not be collected from the blocks which are recently limed or fertilized. Do not collect samples from road side, old bunds, and marshy places or near the shade trees. Collect soil samples at the centre of 4 coffee plants.
- Dry the samples under shade and pack in a polyethylene bags or cotton bags and send to the laboratory properly labelled. Do not use fertilizer contaminated bags.
- Give the details of the estate, crop harvested for the last 5 years, elevation, rainfall details, irrigation schedules if any, variety of coffee and age of the bushes.

5. Hutting

Young plants should be protected from sun light by hutting.

6. CBB management

Follow all the control measures for preventing the infection and spread of Coffee berry borer

7. Winter Irrigation

Indian coffee tracts experience drought period for more than 4 months and sometimes extending up to 6 months. The most important factor which limits the production of coffee even in well managed plantations is the long drought period. In such situation, if irrigation is provided to coffee, then production of coffee can be maintained at most economic level. Robusta being susceptible to drought responds well to irrigation compared to Arabica. Since, coffee plants are evergreen plants, it is necessary to conserve the soil moisture for the best performance of the plants. In case of failure of North –east monsoon, the dry period sets in early during September-October months. Therefore, first winter irrigation needs to be commenced 20-25 days after the cessation of monsoon. Irrigation is to be given (25 mm) once in 20-25 days till the end of December. The shade should be maintained at thin level in irrigated plots and plants have to be pruned immediately after the harvest. Weeds grow very fast in irrigated plots and hence proper timely measures have to be taken to control the weed growth.

Control of Mealybugs in Robusta Coffee

Mealybugs are the most important sucking pests of coffee. Mealybugs are small, soft bodied insects. They infest tender branches, nodes, leaves, spikes, berries and roots in large numbers. Young plants succumb to heavy infestation. Mealybugs multiply rapidly during the hot weather with the cessation of monsoon. Infestation becomes sever in summer. Intermittent showers and irrigation help in the build up of the pest. Excessive removal of shade in Robusta plantations often leads to flare up of mealybugs.

Various species of ants feed on the honeydew and attend the mealybugs. Ants are the carriers of mealybugs and therefore, it is essential to control the movements of ants in the field in mealybug management.

Control Measures:

Control ants by dusting quinalphos 1.5% or methyl parathion 2% around the base of coffee and shade trees. Destroy nests of red ants and cocktailed ants. Spray the affected plants with Ekalux 25 EC (300 ml) or Lebaycid 1000 (150 ml) or 4 litres of Kerosene thoroughly mixed in 200 litres of water with 200 ml of any wetting agent. Maintain adequate shade in the estate. If the roots are affected, then drench the soil near the root zone with any one of the above insecticide except Kerosene.

Bordeaux mixture (0.5%) preparation and method of application

Dissolve 1 kg of pure chemically tested copper sulphate in 10 litres of water by suspending it in a gunny bag or cloth bag overnight. Similarly prepare spray lime solution by dissolving 1 kg of spray lime in 10 litres of water. Take 180 litres of water in a barrel and add the freshly prepared lime solution and stir it well. Now slowly add copper sulphate solution to the above lime solution with vigorous and constant stirring. This gives the 0.5% Bordeaux mixture. Do not put lime solution to copper sulphate solution while preparing the Bordeaux mixture. By doing so, the adhering capacity of the spray solution drastically reduces due to the formation of coarse precipitate. Such mixture does not stay longer on the leaf surface and liable for easy fall and wash off.

The Bordeaux mixture is very effective when its pH is between 9.0 and 10.0. It is advised that the pH of the prepared Bordeaux mixture solution should be checked with pocket pH meter. Before the preparation of B.Mixture, it is further stressed that the procured spray lime and copper sulphate samples have to be tested in the laboratory for their purity so that the right quantity of lime and copper sulphate can be added during the preparation of quality Bordeaux mixture.

Infact, if the purity of the spray lime is 100%, then to prepare a 0.5% Bordeaux mixture one should use only 300 gms of spray lime. But unfortunately, the quality of spray lime available in the market is not meeting the actual specification all the time. Hence, one can use a maximum of 1 Kg of spray lime while preparing the B.mixture. Do not use agricultural lime for the preparation of Bordeaux mixture. One should be cautious that, only freshly prepared Bordeaux mixture should be used for spray. Do not use the mixture which was prepared in the previous day. For leaf rust control spray the solution uniformly only to the lower portion of the leaves. In the case of black rot (where 1% Bordeaux mixture is used), both upper and lower portion of the leaves have to be covered with spray for effective control of the disease.

Do not add any foreign ingredients to the Bordeaux mixture like urea, phosphatic fertilizers, micro-nutrients, insecticides, pesticides and hormones.

Shade Trees and their Importance

Coffee tracts in India receive both South-West and North-East monsoon rains from June to December. The N-E monsoon rains are received generally during October to December. In some years the N-E monsoon tapers off by the end of October it self leading to extension of dry period in these areas. Hence, in India coffee areas encounter 4-6 months of dry spell in a year. Therefore, the coffee plants experience fluctuating weather conditions like continuous wet condition, hail stone, heavy winds, prolonged drought and dry periods. These conditions forced our coffee farmers to grow coffee under shade.

Shade trees essentially help in preventing large variations in soil temperature and moisture levels. Shade trees reduce the intensity of sun light and temperature, combat drought effects and maintain moisture levels in coffee plant tissues and protects the plants from low temperature. Shade trees also protect the coffee plants from hail stone damage, high wind velocities and prevents over bearing of the plants. Adequate shade improves soil fertility by way of returning large amounts of leaf litter to the soil. The fallen tree leaf litter improves the organic matter in the soil thereby

increasing the useful micro-organism status in the soil. A properly maintained shade also helps in limiting the incidence of coffee pest and diseases. Coffee grown under shade is always found to be of superior quality and taste. Shade trees are therefore recommended as a protective measure when environmental conditions can be harsh especially in areas which are prone to high temperature, extended drought, heavy rain fall, high winds and occurrence of hail storm.

In India, two tier shades is necessary for growing coffee especially for Arabica. All trees can provide shade but some are planted with well defined objectives to provide desired shade. Therefore while selecting the shade trees; one should see that the selected tree species should have the following properties:

(i) They should grow fast
(ii) Trees those shed leaves during the rainy season but put forth fresh shoots faster immediately after the rainy season
(iii) Resistance to speedy winds. They should offer resistance to hail stones.
(iv) Should have deep root system so that they do not compete for applied nutrients and soil surface moisture
(v) They should not harbour/host pest and diseases affecting coffee
(vi) Select trees which give filtered shade

COFFEE WITH TWO TIER SHADE TREES

Arabica coffee requires 50-60% of the filtered shade for maintaining good consistent production. The shade tree branches have to be regulated properly in order to provide desired shade to coffee plants. Shade regulation should be done only when sufficient moisture is present in the ground soil. The permanent shade trees can be regulated every year by lopping the braches at height of 30-40 feet to provide required light and air circulation in the field. In Arabica plantations situated at higher elevations (more than 3700 feet) having two tier shade canopy of dadap (lower) and permanent (upper) shade trees, shade regulations can be done during February or

March months. In irrigated Robusta fields, the shade regulation can be undertaken immediately after the harvest. While in rain fed plantations shade regulation should be done only after the receipt of 4-5 inches of rain. Dadap lopping should be undertaken immediately after the onset of monsoon and all the stakes should be finely chopped and returned to the field along with the leaf mass.

Labour scarcity is one of the major problems in coffee plantations and availability of skilled workers for shade regulation limited. Therefore, in plantations while choosing the new shade trees, one has to prefer those shade trees which shed leaves during the monsoon but sprouts quickly after the monsoon. Atti and Havalige (Balanji) belong to this category of trees. Timber extraction in Arabica fields should be done only after establishing the permanent shade trees along with required number of dadap trees well in advance of 2-3 years in the area where removal of shade trees is proposed. Silver oak trees can be extracted when they reach the age of 30-35 years. Maintenance of monoculture shade especially silver oak should be strongly discouraged in coffee plantations. The temperature of the soil in such plantations is generally higher than other fields. The incidence of white stem borer, leaf rust and black rot disease is also more in silver oak shaded plantations.

The popular kinds of shade trees belong to the *Ficus* family like *goni, basree, mitlee* and *atti.* These trees have large spreading braches and deposit large quantity of leaf litter in the soil. Albizzia family (leguminosae) trees like kal bage or hotten bage are also good shade trees. Jack trees are very common in plantations in South India. But the jack fruits should be removed before they mature in order to avoid cattle and monkey menaces.

Retaining higher levels (thick) shade during the monsoon results in the incidence of black rot and stalk rot diseases in coffee plants and berry drop due to chillness in the soil. When the over head shade is more than desired, vegetative growth of the coffee plants will be higher and in such plants flower bud formation will decrease. The plots or estates exposed to western aspect should have high shade canopy of 60-70% and also the lower branches of the shade trees should be retained on the border rows. Silver oak or silk cotton trees should be planted closely in zigzag manner as a shield belt for reducing the exposure to evening sun. Do not train pepper vines in all the shade trees. The number of vines can be limited to 100 per hectare in Arabica.