SILVER JUBILEE YEAR 2008-09

CISH Technologies for Commercialization

CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE
Rehmankhera, P.O. Kakori, Lucknow - 227 107

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Central Institute for Subtropical Horticulture
P.O. Kakori, Rehmankhera,
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Published by

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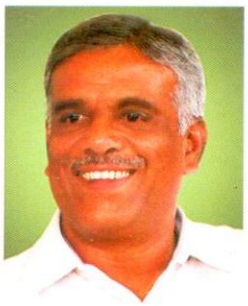
Silver Jubilee Year 2008-09

Foreword



I am pleased to inform you that the Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow is publishing CISH Technologies for Commercialization in its Silver Jubilee Year 2008-09. It embodies a number of proven technologies which are exceedingly fruitful for horticultural farming. The Institute has several achievements to its credit since its establishment as an independent Institute in June 1984. It has been carrying out research on subtropical fruits to cater to the demands of food and nutritional security of the people in the wake of burgeoning population, rapid urbanization and limited cultivable land.

The Institute has been one of the major players in the horticultural development of the country. It has contributed significantly in improving the scientific production of fruit crops like mango, guava, aonla, bael, etc. The Institute has the largest collection of more than 700 accessions of mango in its field gene bank. A red blushed coloured mango variety Ambika, a cross between Amrapali and Janardan Pasand, has been developed and released for commercialization by the Institute. The Institute has also developed quality varieties of guava named Lalit and Shweta and bael CISH B-1 and B-2, which are other worth mentioning contributions. Besides, the Institute has developed technologies/techniques for the rejuvenation of old and senile orchards of mango, guava and aonla, high density and ultra high density plantation in mango and guava, control of irregular bearing in mango, etc.

Of late, fruits have become an important part of our food on account of awareness and improvement in the standard of living. Considering the medicinal and nutritive values of fruits, orchardists need to give importance to their cultivation as commercial crops. It may not merely be beneficial for the people of the country as food and nutritional security but also the economic condition of the orchardists will improve simultaneously. The development of horticulture will directly add to the agricultural contribution in the national gross domestic product. I hope this publication will be extremely useful to the nurserymen, orchardists, traders and processors.

(B.M.C. Reddy)
Director

Contents

Mango varieties

Ambika

This is a variety developed from a cross between Amrapali and Janardan Pasand and released in the year 2000 for commercial cultivation. The variety acquired regular bearing and fruit qualities from Amrapali and red peel colour from Janardan Pasand. It has wide adaptability and is performing well in climatologically contrasting regions as far as mango varieties are concerned.

The tree is semi-spreading with sparse canopy. It is a regular bearing variety and matures late in the season. Average fruit yield is 80 kg plant^{-1} at the age of 10 years. The fruit is oblong oval in shape having a size of 11.75 x 7.65 x 6.53 cm and weighs 250-350 g fruit^{-1}. Fruits are purple green at maturity and turn bright yellow with dark red blush upon ripening. The ripe fruit is firm with scanty fibre, pulp colour is orange yellow and TSS develops up to 21° Brix. The shelf life of fruit is 8 days. The variety has potential for export and internal market because of its attractive fruit colour.

Dashehari-51

A lot of variation has crept in the fruit quality and yield attributes of Dashehari mango because of indiscriminate multiplication from unknown sources for several years. A regular bearing and high yielding clone of Dashehari was selected by exploiting clonal variability. Besides bearing regular crop every year, this clone gives 38 per cent more yield than other Dashehari trees. The reproductive and vegetative growth is well distributed on the tree underlying the reason for its regularity of bearing. The index of irregular bearing of this clone is less than other trees. Regularity coupled with high yield of this clone will lead to increased production of mango cv. Dashehari. It can be grown in all the regions of mango cultivation and at present is in high demand.

Guava varieties

Lalit

The guava variety Lalit released by the Institute is a high yielder with pink pulp colour. It is a selection from half-sib population of Apple Colour. It is a variety with wide adaptability in different agro-ecological zones of the country. Lalit is responsive to pruning and is suitable for high density planting.

The fruit yield is 100 kg plant^{-1} at the age of 6 years, which is higher than any other commercial guava variety. Fruits are of saffron yellow colour with red blush and weigh 185-200g fruit^{-1}; flesh firm and pink with good blend of sugar and acid. The content of vitamin C in fruit is 250 mg 100g^{-1}. It is suitable for both table and processing purposes. The pink colour in the beverage remains stable for more than a year during storage. The variety is suitable for cultivation in guava growing areas of the country.

Shweta

It is a selection from half-sib population of Apple Colour. Tree is semi vigorous with medium height and prolific bearer. The fruit yield is 90 kg plant^{-1} at the age of 6 years. It is a variety with medium size globose fruits, weighing 225g fruit^{-1}, creamy white epicarp having red spots or blush, snow-white flesh, TSS 12.5-13.2^{0}B, vitamin C content 300mg 100g^{-1} pulp and good keeping quality. The variety is suitable for cultivation in guava growing areas. It is a high yielder. Fruits are attractive and have good nutritive value.

Bael varieties

CISH B-1

CISH Bael-1 is a selection from open pollinated seedlings. It is a mid season variety which matures during April-May. Trees are tall, vigorous with dense canopy, erect growth habit, precocious and heavy bearer. Fruit shape is oval to oblong; fruit size 15-17.8 cm in length and 39.2-41.0 cm in circumference; average fruit weight 1.01kg. Fruit colour turns to lemon-yellow on ripening. Fruits are thin shelled with 0.12-.15 cm thick skull, pulp is dark yellow with pleasant flavour and less mucilage content. Seed content is 38 seeds fruit^{-1} with seed to pulp ratio 1:206. It has a very good taste and flavour. Fruits have 65.57 per cent pulp, TSS 38.0°B. Fruits are also good for processing total carotenoids 1.18mg 100g^{-1} pulp, total sugar 20.54 per cent and tannin content 3.5 per cent. The yield of fully grown up tree varies from 50-80kg.

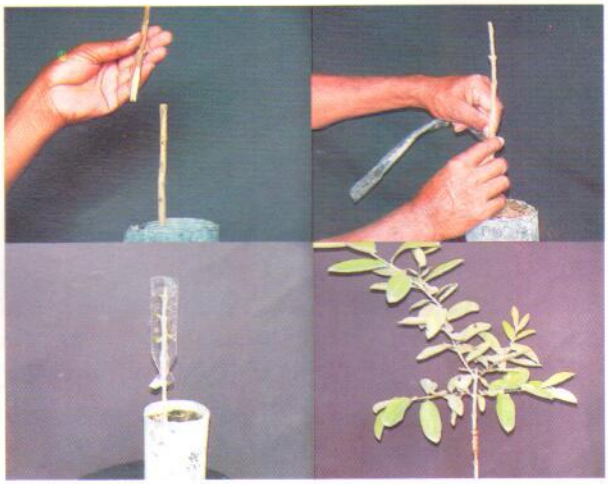
CISH B-2

It is also a selection from open pollinated seedlings. Tree is dwarf with medium spreading habit. Foliage is sparse and almost thornless; precocious with moderate bearing habit. Fruits are oblong to round in shape with average length of 14.80cm and circumference of 52.64 cm. Fruit weight is from 1.80-2.70 kg fruit^{-1}. Fruit pulp is orange yellow and shell is thin 0.24-.26cm. Seed and fibre contents are low with average seed number 50.12 fruit^{-1} and average seed weight 4.40g, Seed to pulp ratio is 1:270. It has good taste with pleasant aroma. It has 61.32 per cent pulp, 31.90° B TSS, 0.99mg 100g^{-1} total carotenoids, 16.33 per cent total sugars and 2.45 per cent tannin content. The yield of the grown up tree varies from 60-90kg.

Bael variety CISH B-1 is suitable for canning and slices preparation, whereas CISH B-2 is excellent, high yielding variety for processing with pleasantly aromatic pulp.

Cleft/wedge grafting in guava, aonla and bael

Inarching has long been used as a method of vegetative propagation in guava. The technique has been used by most nurseryman even though tedious and cumbersome. So, nurserymen friendly preoperational technique in fruit crops has been standardized.



Seedlings are raised for rootstocks in the nursery for 6-12 months. Seedling of pencil thickness (0.5-1.0 cm), with growing apex are ideal for this technique. The scion shoot of similar thickness with 12-18 cm long is used for grafting. Selected scion shoots are defoliated on the mother plant, 5-7 days prior to detaching and apical growing shoot is beheaded. Rootstock (seedling) is headed back retaining 15-20 cm long stem above the soil. The beheaded rootstock is split to about 4.0-4.5 cm deep through the centre of the stem with grafting knife. A wedge shaped cut, slanting from both the sides (4.0-4.5 cm long) is made on the lower side of the scion shoot. The scion stick is then inserted into the split of the stock and pressed properly, so that cambium tissues of rootstock and scion come in close contact. The union is then tied with the help of 150 gauge polythene strip, 2 cm in wide and 25-30 cm in length. Immediately after grafting, the graft is covered with 2.5 x 18.0 cm long polythene tube (cap) which is tied with rubber band at the lower end. The grafts are kept in mist chamber/ polyhouse. The scion starts sprouting after 9 to 12 days which is visible from out side. The cap is removed after 25-30 days in the evening hours. The grafts are transferred from mist chamber to 50 per cent shaded net house for hardening. In case of open condition, the grafts are kept in partial shade.

The method of cleft/wedge grafting is cost effective and easy. The traditional methods of propagation such as inarching in guava, and budding in aonla and bael can easily be replaced successfully with this new technique. The technique results in rapid multiplication of guava, aonla and bael plants throughout the year. The technique has tremendous potential for commercialization by private nurserymen.

High density orcharding in mango

High Medium density orcharding is one of the ways to increase the productivity of mango. It requires accommodating more number of plants per unit area as compared to traditional planting and managing the trees by adopting judicious training and pruning.

In traditional mango planting system 100 trees are accommodated (10 x 10m) in a hectare whereas high density planting system requires 400 trees to be planted at 5 x 5m. In this system, the pruning and training should be a part and parcel of the canopy management right from establishment of the orchard. Estimated fruit yield realised through high density is about four times more than the traditional system of planting. The high density planting can realise 4-5 times higher economic returns as compared to traditional planting density, if good management practices are maintained.

High density planting system has been found the most appropriate for mango orchardists as it not only increases the productivity but also provides higher returns per unit area.

High density planting in guava

Guava is usually planted at 6.0 m x 6.0 m spacing (277 plants/ha). Guava responds very well to pruning so it has bright prospects for high density planting to get high productivity per unit area. Institute started high density planting at a spacing of 3m x 1.5m (2222 tree/ha^{-1}), 3m × 3m (1111 plants/ha) and 3m×6m (555 plants/ha). Pruning technique is really a valuable technique in controlling tree size and improving the fruiting potential of guava trees under high density planting.

Eight year's after planting, the highest fruit yield (159.39 kg/plant) was recorded from the trees spaced at 3.0 m x 6.0 m followed by 124.12 kg/plant under 6.0 m x 6.0 m spacing. Trees spaced at 6.0 m x 3.0 m had more (158.8%) fruit yield as compared to trees spaced at 6.0 m x 6.0 m.

Pruning treatment increased the fruit weight, vitamin C and total sugar content of harvested fruits from 3.0m x 6.0m density as compared to 6.0m x 6.0m spaced trees. Trees spaced at 3.0m x 6.0m had heavier fruit weight (228.3g) as compared to 6.0m x 6.0m spaced trees (206.1 g).

High density planting coupled with canopy management produced 47.1 tons ha^{-1} at 3.0m x 6.0 m as compared to 6.0m x 6.0m spaced trees (28.53 tons ha^{-1}). Thus fruiting potential of guava is maximized to obtain higher yields. This technology has become popular among the farmers across the country.

Meadow orcharding or Ultra-high density planting in guava

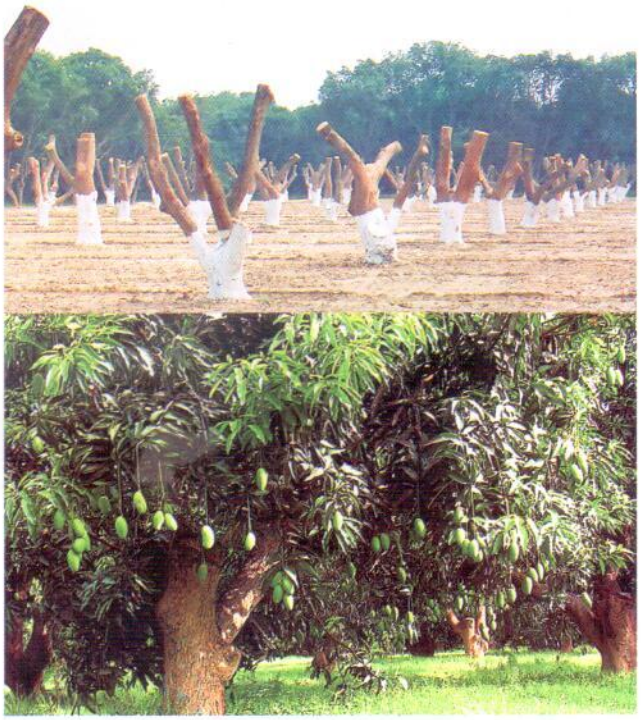
Response of guava to training and pruning is well established. To get higher productivity of guava a new planting system was needed.

In meadow or ultra-high density orchard, production starts from the very first year of planting and the productivity is higher with superior fruit quality besides ease of tree management. The technology is gaining popularity among the orchardists, especially in Maharashtra.

A meadow orchard system or ultra-high density planting of guava has been developed which accommodates 5000 plants ha^{-1} at 1.0 x 2.0m spacing. The plant canopy is managed judiciously with regular topping and hedging. In order to maintain dwarf tree structure, plants are topped 2 months after planting, i.e., in the month of October, for emergence of new shoots below the cut end. After appearance of new shoots, 50 per cent of the shoots are pruned again in December-January for further induction of new shoots. Growth is initiated, flower differentiates, and well spread plant canopy is attained by the end of May. Heading back of entire shoots is repeated every year in September, May and January for dwarf tree canopy and better fruiting. An average yield of 12.5 tonnes ha^{-1} is obtained after first year which reaches up to 55 tonnes ha^{-1} after 3 years.

Rejuvenation of old and senile mango orchards

Approximately 35-40 per cent of mango orchards are more than 40-50 years old and their productivity has declined particularly due to over crowding and overlapping of branches. The uprooting of unproductive orchard and establishment of a new one takes around 10 years. Therefore, a technology was required to be developed to increase the productivity of such orchards through rejuvenation.



The technology involves pruning/heading back of branches during December at a height of 4 meters from the ground. About three to four main branches, with outward growth, are retained. The undesirable branches are completely removed from their base. The main branches (3-4 only) are allowed to produce shoots and develop canopy. The fungicidal paste, prepared by mixing 1 kg copper oxychloride, 250 g castor oil and water to the desired consistency is applied on the cut surfaces immediately after pruning to check microbial infection. The tree attains umbrella like open canopy of healthy shoots with good bearing potential within three years of pruning. The rejuvenation technology with effective after-care management could give new lease of life to the unproductive orchards for another 25-30 years and make it productive and economic. After two years of pruning, the trees become rejuvenated with development of healthy and productive canopy and start-bearing fruits.

The technology has made a good impact and is being constantly in demand for rejuvenating the unproductive orchards. It not only generates income through sale of cut wooden branches but also through intercropping during the initial years. It has immense potential to revolutionize mango productivity from old and senile orchards.

Rejuvenation of unproductive guava orchards

Guava orchards loose their productivity due to ageing at 25yars and biotic stresses. Rejuvenation of guava orchards was needed to reimpose vigour and yield in the crop.

The technology involves heading back of trees, 1.0 to 1.5 meter above the ground level during May-June or December-February to facilitate production of new shoots and allow the development of fresh canopy of healthy shoots. The newly emerging shoots are allowed to grow up to a length of about 40 to 50 cm, which could be attained in 4 to 5 months after cutting the tree. These shoots are further pruned to about 50 per cent of the total length for emergence of multiple shoots below the cut ends. Multiple shoots developed as a result of second pruning lead to flowering and fruiting in the following season. Yield enhancement in the range of 70 to 90 per cent over the un-pruned trees can be recorded after first year of rejuvenation. Additional income from the sale of pruned wood and intercrops can also be obtained. Higher yields are realized due to better harvesting of solar radiation by the tree canopy, removal of dead and diseased branches and judicious intercultural operations.

This technology is gaining popularity among farmers. The NHM has also included this technology for adoption in guava growing areas.

Management of irregular/alternate bearing in mango

Irregular bearing is one of the most serious problems of mango as it renders mango cultivation less remunerative and is one of the main hurdle in maximizing the mango production.

Excessive vegetative growth, high gibberellin synthesis, imbalance in C/N ratio at the time of flower bud genesis and heavy fruiting in one year causing deficiency in nutrition for fruiting in the following year have been attributed as the major factors for alternate bearing. Most of the commercial varieties of Uttar Pradesh namely, Dashehari, Langra, Chausa, Bombay Green and Lucknow Safeda are alternate bearers.

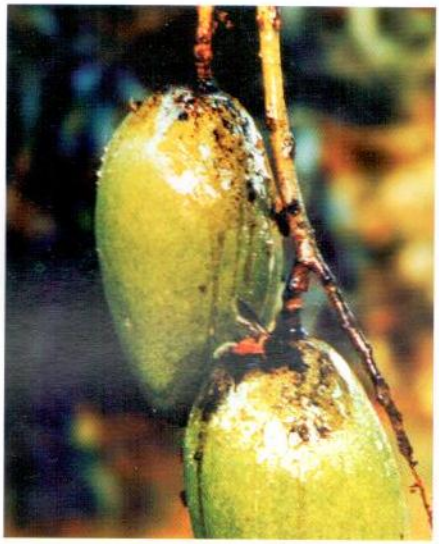
The application of paclobutrazol @ 3.2 ml m^{-1} canopy diameter through soil drenching during the month of September has been found to ensure regular bearing in mango. Response of paclobutrazol varies with the variety. Fruiting in mango cv. Dashehari could be regulated by the application of full dose of paclobutrazol in the first year followed by half dose in the second year. However, in cultivars Chausa and Langra regular application of paclobutrazol is required. The application of paclobutrazol resulted in increase of fruit yield by 25 per cent during 'on' year and 60 per cent during 'off' year.

The technology has been recognized as viable technology for enhancement of productivity of mango. A large number of mango orchardists are using the technology for higher and regular yields.

Integrated pest management in mango

Mango Hopper (Idioscopus clypealis, I. nitidulus and Amritodus atkinsoni)

Mango hoppers are most destructive insect pests of mango. Nymphs and adults puncture and suck the sap of tender parts, thereby reducing vigour of plants and particularly destroying the inflorescence and causing fruit drop. Heavy puncturing and continuous draining of the sap causes curling and drying of the infested tissue. They also damage the crop by excreting a sweet sticky substance which facilitates the development of sooty mould.



Integrated management

- Avoid dense planting
- Pruning of overcrowded and overlapping branches in December
- Orchards be kept clean by regular ploughing and removal of weeds.
- First spray of imidacloprid (0.005%) when panicles are 8-10 cm long followed by second spray of thiamethoxam (0.005%) or propanophos (0.05%) after fruit set and third need based spray of carbaryl (0.2%) before maturity.

Mealy bug (*Drosicha mangiferae*)

Nymphs and adults suck the plant sap and reduce the vigour of the plant and destroy inflorescence and cause fruit drop.Excessive and continuous draining of the plant sap causes wilting and finally drying of infested tissue. They also excrete honey dew, a sticky substance which facilitates the development of sooty mould. The female adult crawls down the tree in April-May and enter the soil and lay eggs which hibernate in soil till mid December.

Mealybug infestation

Polythene banding

Integrated management

- Ploughing of orchard in November-December
- Banding of tree trunk above 30cm ground level with polythene (400g), and application of *Beauveria bassiana* product ($2gl^{-1}$) or five per cent NSKE around tree trunk in last week of January.
- Conservation of biocontrol agents, viz. fungus, *Beauveria bassiana* predators, *Menochilus sexmaculatus, Rodolia fumida* and Sumnius renardi.
- Raking of soil around tree trunk and mixing with chlorphyriphos dust (1.5%) @ 250 g $tree^{-1}$ during January.
- If nymphs have ascended the tree, spray carbosulfan (0.05%) or dimethoate (0.06%) during flowering.

Inflorescence midge (*Erosomyia indica* Grover)

The pest attacks mango crop at three different stages from January-May. The first attack is at floral bud burst stage. The larvae tunnel the axis of inflorescence and destroy it completely. The mature larvae make small exit holes in the axis of the inflorescence and slip down into the soil for pupation. Second attack starts at the fruit set as young maggots bore into these tender fruits, which slowly turn yellow and finally drop. The third attack is on tender new leaves encircling the inflorescence. The most damaging one is the first attack in which the entire inflorescence is destroyed. The inflorescence shows stunted growth and its axis bends at the entrance point of the larvae. It finally dries up before flowering and fruit setting. The symptom of attack of the pest is appearance of tiny black spots on inflorescence.

Integrated management

- Deep ploughing of orchard in November-December to expose pupae and diapausing larvae to sun's heat which kills them.
- Soil application of 1.5 per cent chlorpyriphos during April-May to kill larvae fallen on the ground.
- Spray fenitrothion (0.05%) or dimethoate (0.045%) at bud burst stage.

Fruit fly (*Bactrocera dorsalis* Hendel and *B. zonata*)

It is one of the most serious pests of mango in the country which restricts the export of fresh fruits. Its infestation is more in southern states than in northern states. The female punctures the outer wall of mature fruits with the help of its pointed ovipositor and insert eggs in small clusters inside the mesocarp. After hatching, the larva feeds on the pulp of fruits which appear normal from outside but drop down finally.

The mature maggots fall down into the soil for pupation. The emergence of fruit fly starts from April onwards with maximum population during May-July coinciding with fruit maturity. The population declines slowly from September-December.

Fruit fly infested fruit

Fruit fly Trap

Integrated management

- Collection and disposal of infested and fallen fruits.
- Ploughing of orchard during November-December to expose pupae to sun's heat which kills them.
- Hanging of methyl eugenol wooden block traps on tree (5x5x1cm) branches soaked in ethanol, methyl eugenol and malathion (6:4:1) for 48 hrs. during fruiting period from April to August @ 10 traps ha^{-1}.
- Early harvesting of mature fruits
- Spray carbaryl (0.2%) or fenthion (0.05%) with jaggery/molasses commencing at preoviposition period and repeat at 15 days interval, if infestation is severe.

Leaf webber (*Orthaga euadrusalis*)

The pest is attaining serious proportions in northern states. Old orchards with less space between the tree canopies harbour more insects than open orchards. Its infestation starts from the month of April and goes up to December. Initially caterpillars feed on leaf surface by scrapping. Later they make web of tender shoots and leaves together and feed within. The infestation is severe under shady conditions.

Damage by leaf webber

Leaf web removing device

Integrated management

- Mechanical removal of leaf webs by leaf web removing device developed by CISH and burning them.
- Ploughing of orchard during November-December.
- Two to three sprays commencing from last week of July with carbaryl (0.2%) or quinalphos (0.05%).

Hot Water Treatment for Control of Post Harvest Diseases of Mango

Anthracnose *(Colletotrichum gloeosporioides)*, stem end rot *(Lasiodiplodia theobromae)* and Aspergillus rot *(Aspergillus niger)* are the major post harvest diseases of mango fruits. A technology that would control pathogens without adversely affecting fruit quality was needed urgently.

Fruits are treated in electrically operated circulative water bath at 52 ±1^{0}C for 20 minutes. The duration of fruit treatment can be reduced to 10 minutes by supplementing Carbendazim or Prochloraz (both @ 0.05%) in hot water if the fruits are stored at ambient conditions. However, for storage of fruits at low temperature, the Carbendazim or Prochloraz dose is to be increased from 0.05 to 0.1 per cent. After treatment, fruits are air dried and packed in CFB boxes. The fruits can be stored at ambient temperature for 8 -10 days and at low temperature up to 2 - 3 weeks without infection of any post harvest pathogen.

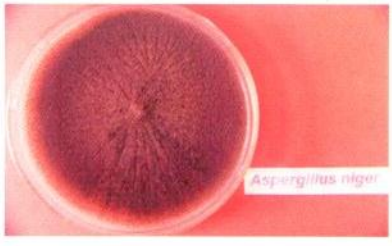
The technology is very effective in controlling post-harvest diseases without adversely affecting the quality of North Indian mango cultivars, viz. Dashehari, Langra, Chausa, Mallika and Amrapali. The technology is being used for marketing of mango fruits for domestic as well as export market.

Aspergillus niger (AN-17) for Management of Guava Wilt

Wilt disease of guava is a national problem and loss due to this disease is substantial. Since the disease is soil borne in nature, its control is difficult. However, Disease management could be done by employing competitive saprophytic fungi such as *Aspergillus niger* strain AN17 (biological control).

One week old culture of bio- agent @ 0.1 per cent (1g/kg) is mixed in farm yard manure (FYM) bed (1 m x 2 m x 30 cm), water is sprinkled over the bed to increase moisture and covered with polythene sheet. After 4-5 days, the polythene sheet is removed, light amount of water is sprayed in the bed for proper mixing of bio agent and again covered with polythene sheet. The process is repeated 3 times for proper multiplication of *A. niger* in FYM. The bioagent rich FYM becomes ready for application in 20 days.

The bio-agent, *A. niger* enriched FYM, is applied at the time of planting of guava plants in pit (5 kg pit^{-1}). In grown up plants, 10 kg bio-agent is applied near the root zone in basin and mixed properly. The practice is repeated every year in the month of June as a preventive measure for the control of wilt disease of guava.



Mango Harvester

Mango is harvested traditionally in a variety of ways including shaking of branches, hand picking, twisting and pulling action, beating by sticks and pulling by local harvester. This, some times results in bruising and quality loss as sap oozes out and spreads on the surface of fruits, resulting in spoilage due to microbial infection. As per international requirement and Codex alimantarius, fruits should be harvested along with 1.0 cm pedicel. Keeping these points in view a mango harvesting device was designed and developed. It consists of a leaf shaped frame, V – blade of high carbon steel, divider to guide fruits and a nylon pouch to receive the fruits. It works on the principle of holding, pulling and shearing forces. To make the harvester lighter, 25 mm diameter aluminum handle (4.0 m in length) has been attached.

CISH Mango Harvester has been found suitable to harvest fruits having pedicle of 1.0 cm in length. It saves about 50 per cent energy of operation as compared to traditional one and harvest around 600 to 800 fruits per hour from a good bearing tree, having a height of 4.0 m.. The cost of the Mango harvester is Rs. 250.00 with nylon pouch having aluminum handle. This device has gained popularity amongst mango growers.

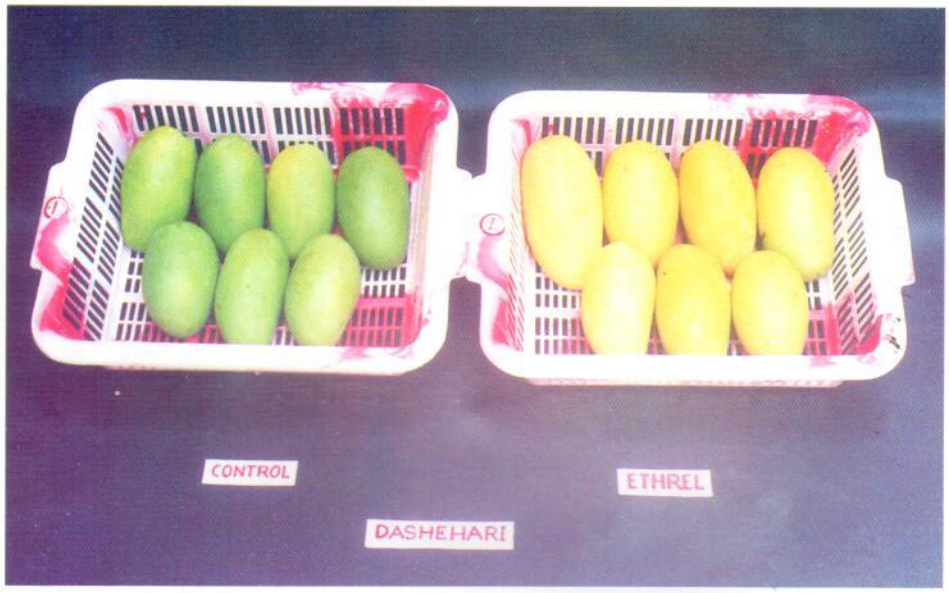
CFB boxes for packing of fruits

Mango and guava fruits are packed in wooden boxes, weighing 2.0 - 2.25 kg and having 50 – 55 metallic nails with higher percentage of ventilation. It has been observed that 14 – 20% loss occur in mango packed in wooden boxes, due to impact, compression, shock, vibration and frictional forces during transportation. Moreover, due to higher ventilation, proper environment is not maintained inside the box. Keeping above points in view, telescopic type CFB (Corrugated Fibre Board) box of 2.0 and 4.0 kg capacities having 0.5 per cent ventilation were designed, as an alternative to wooden boxes on the basis of Codex alimantarius for packaging of mango and guava fruits. Boxes were found safe, attractive, sturdy and satisfactory for handling and shipping of fresh produce.

For safe and bruise less shipping of fresh produce, CFB boxes have gained popularity. These are suitable for export of fruits due to attractiveness, light weight and appropriate ventilation.

Uniform ripening of mangoes with ethrel

The farmers start harvesting premature mango fruits to capture early market and get remunerative price. However, these fruits do not ripen uniformly under normal conditions and calcium carbide, a banned chemical is used to ripen them, which results into uneven ripening. Therefore, an alternate technology for uniform ripening of mango fruits was developed. This involves dipping of fruits (100 kg) in 100 litres of water containing 62.5-187.5 ml of ethrel/ethaphon at 52±2^{0}C for 5 minutes. The concentration of ethrel depends upon maturity of fruits; less mature fruits require higher concentration of the chemical. The same solution can be used up to 4 times to ripen the fruits, which reduces the input cost. Fruits ripen uniformly with attractive yellow colour without spoilage within 4-6 days. The technology is not only beneficial for traders and exporters but also for processors as the ripening period is worked out according to fruit maturity.

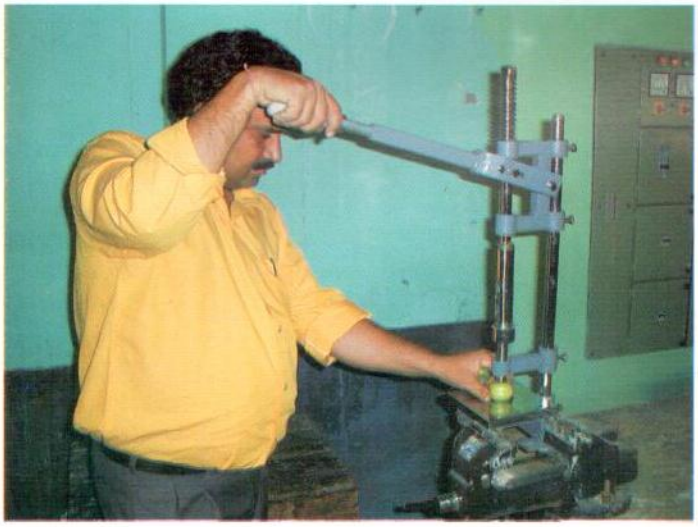


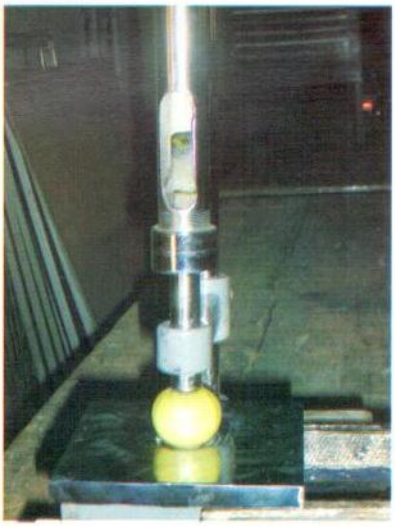
Aonla De-stoning Machine

The manual removal of stone from fresh aonla fruits is a difficult proposition due to the irregular shape of stone and its strong bondage with mesocarp fibers. There was a demand from the processing industry to have such a device wherein stones can be removed from the fruits for the preparation of newer and quality products. Therefore, a manually operated machine was designed and developed for de-stoning aonla fruits. The machine works on the principle of compression and coring. The main functional parts are plunger, core and a die. The capacity of machine to de-stone aonla fruits is 10 - 12 Kg hr^{-1}. Only 6 - 8 percent of the pulp remains adhered to the stones during de-stoning operation with the machine and fruit remains intact. Whereas, manual de-stoning is a cumbersome process, fruit is broken down into segments and 15 - 20 percent pulp remains adhered to stones. The cost of a machine is around Rs. 3000.00.

Five prototypes were passed on to aonla processing industries for pilot scale testing and preparation of products. The machine has been found useful for removal of stones from aonla.

For easy and clean removal of stones from aonla fruits with minimal loss, the machine has proved useful.





Cabinet type solar De-hydrater

Open sun drying of fruits is an age old practice but it attracts insect - pests, dust and other foreign materials and the drying time is long and product is unhygienic and of poor quality. The other sources of energy such as electricity and gas are not assured at the farm level. Therefore, to overcome these problems, a cabinet type solar dehydrater having 5.0 kg capacity was designed and developed for on farm dehydration of fruits and vegetables.

It consists of an insulated box covered with ordinary glass and aided with a sun rays reflector (mirror). Bottom of the box is painted with black colour. Sun rays penetrate through the ordinary glass and are absorbed by the black surface thereby converting into heat which raises the temperature of the box. It is further increased with the help of reflector. Product to be dehydrated is spread on perforated aluminium trays. Dehydration is regulated with air vent provided in the cabinet. Hygienic quality product can be dehydrated in shorter period as compared to open sun drying.

Raw mango slices, mahua flowers, aonla pomace, potato chips, chillies could be dehydrated in a short time. During the month of May and June (ambient temperature 35 to 42^{0}C) inside temperature may rise up to 82^{0}C. It can also be used for cooking of food in rural areas due to its portability. Each unit costs Rs. 5000.00 at present. Forty units were sold to Department of Horticulture, U.P. for distribution to the farmers for on farm dehydration of fruits and vegetables.

Raw mango squash (panna)

Raw mangoes are used to prepare pickle, amchoor and chutney. Mango panna, a traditional drink, is prepared in homes and consumed fresh. A technology was required wherein a uniform quality of panna could be produced under hygienic conditions, which can be stored for a fairly long period under ambient conditions. This is done by extraction of pulp by boiling the hard green mango fruits (1 kg) in water (1 lt.) having grinded properly. Salt (120 g), black salt (80 g), roasted cumin seeds powder (40 g), fresh mint leaves (200 g) and citric acid (65 g) are added. Mixture is strained and sodium benzoate dissolved in water (1 g) is added. For sweet squash, 450 g of sugar is added while for preparing sour squash, 450 g of water is added. The squash is made to 2 kg by weight by adding water. The glass/plastic bottles filled with squash are sealed. The product could be stored for 9 months. It is served by diluting one part of squash with seven parts of chilled water. Raw mango squash developed by this technology ensures unspoiled product used for off-season panna preparation and can be stored for prolonged time over shelf.

Aonla segments-in-syrup

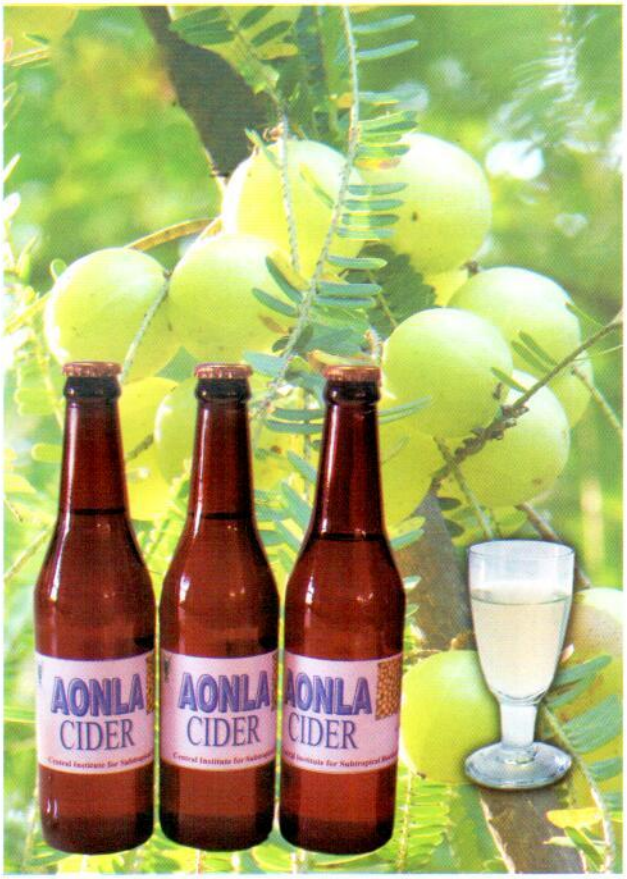
Aonla is a nutritious fruit but due to its astringent taste its fresh consumption is limited. So, it is processed into a number of products and the demand for newer products of the fruit is increasing as the people are becoming more health conscious. Aonla murabba is a traditional product but its nutritional quality is poor since the production technologies were not standardised. Moreover, it poses problems during consumption. Development of an equivalent product having high quality and nutritive value was needed. Aonla segments-in-syrup is a new and alternate product to aonla murabba. The product is prepared by blanching the fruits in boiling water, separating the segments and dipping them in successively increasing concentrations of sugar syrup from 50 to 70^{0}B containing preservative and acid. The time required for preparation of product is 6 days. The segments are packed in 72^{0}B syrup in airtight plastic jars. The product contains 200 mg 100g^{-1} ascorbic acid, which is quite higher than that of murabba.

Guava cider

Guava is one of the richest natural source of ascorbic acid and is often called poor man's apple. Ready to serve guava beverage is quite popular in market. However, unlike apple its cider is not yet available. Guava pulp is fermented with yeast *Saccharomyces cerevisiae* variety *ellipsoideus* Montrachet strain, siphoned, matured and bottled to get a sweetened fermented drink. This mildly fermented beverage has 13° B TSS, 4.0 per cent alcohol, 0.45 per cent acidity and 32.8 mg 100 ml^{-1} ascorbic acid with natural guava flavour. The cider can be stored up to one year under ambient conditions.

Guava cider is nutritious, easily digestible, highly refreshing and invigorative. Since India is one of the major producers of guava, using a part of this produce for development of mild fermented guava cider would be a proper strategy from consumers and market view point.

Aonla cider



Aonla (*Emblica officinalis* Gaertn) or Indian gooseberry is known for its therapeutic properties. It is a rich natural source of ascorbic acid and polyphenols. The aonla fruits are not good for fresh consumption because of astringency and acidic taste and hence processed for preparation of number of products. However, fermented beverages have not been prepared from aonla as yet. Cider is a beverage made 'wholly or partly from the fermented juice of apples' and even from pear, peach and raspberry. Polyphenols and acid required in moderate amounts for cider preparation are present in aonla amply.

Aonla juice (suitably ameliorated) is fermented with yeast *Saccharomyces cerevisiae* variety *ellipsoideus* Montrachet strain, siphoned, matured and bottled to get a sweet fermented drink of aonla having 10° B TSS, up to 4% alcohol, 0.4 percent polyphenols and 66 mg 100 ml^{-1} ascorbic acid. The cider can be stored for a period of over one year and its taste improves further during storage.

Aonla cider is a novel refreshing drink which contains only 4% alcohol and, hence, may be promoted as a health drink. Keeping in view the increasing production of aonla, cider is a drink that can be promoted both in national and international markets.

Mahua flower wine and Vermouth

Mahua (*Bassia latifolia*) the Kalpavriksha, is the highly valued tree among tribal communities whose every part is used for one or the other purpose. The most prevalent use of dried flowers is distillation of the flowers into low quality liquor which is sold at a very low price. The liquor is prepared under most unhygienic conditions without any standardized protocol or quality control.

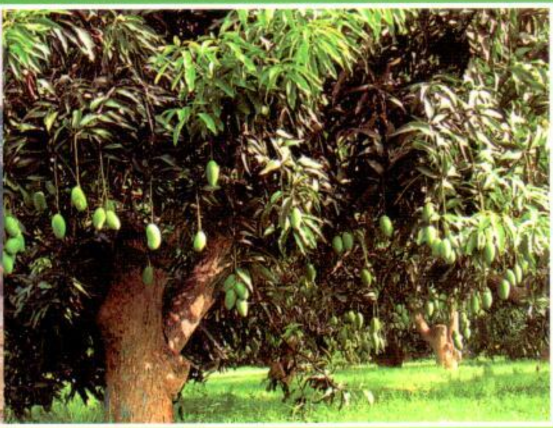
A process has been standardized for fermentation of mahua juice using *Saccharomyces cerevisiae* to obtain good quality mahua flower wine and vermouth. Mahua flower wine has 10% alcohol with light pale colour and pleasant aroma. Mahua vermouth has 10% alcohol with fragrance and taste of traditional Indian spices.

There is an utmost need of upgrading/improving the technology as per international standards for wide acceptance and commercialization of the products in the national and international markets. Wine prepared through the developed method can suppress the offensive mahua smell and makes it comparable to any other fruit wine in colour, clarity and taste.

Aonla dietary fibre enriched biscuits

Biscuits are amongst the lowest cost processed foods in the country. The bakery products available commercially don't contain any fibre despite the fact that they are the choicest snack of children as well as adult alike. Physicians recommend dietary fibre, particularly in children's diet, to overcome many indigestion problems. Dietary fibre, Vitamin C and antioxidant enriched biscuits have been developed by incorporation of aonla pomace (a byproduct generated during aonla juice processing) as one of the biscuit ingredients. The dietary fibre content of the finished product is about 5 times higher than the control while the vitamin C and antioxidant concentrations are 15.6 mg $100g^{-1}$ and 0.25 g per cent respectively. Biscuits have a shelf life of more than 6 months.

The biscuits prepared in accordance with the invented process can be supplemented as fibre, Vitamin C and antioxidant fortified diet for children and adults. The fibre enriched biscuits may be helpful in curing the constipation and other ailments related to fast food habits. More over, it would also help in gainful utilization of aonla processing waste



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