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Chapter 1

Introduction

In India, prominent fruit crops like mango, banana, citrus, guava, and apple make up over 72% of the total area dedicated to fruit cultivation, whereas indigenous (native) fruit crops occupy just 6.56% of the land (0.437 million hectares) but exhibit relatively high productivity (11.47 tons per hectare) (NHB, 2019). Climate change is causing an increase in air temperatures, UV radiation, and the occurrence of extreme events, such as droughts or floods, which, particularly in arid or semi-arid regions, can lead to a worsening of the adverse effects of salinity, nutrient deficiencies/toxicities, as well as disease and insect pest infestations on crops (Gora *et al*., 2019; Chatzistathis *et al*., 2021; Mumivand *et al*., 2022; Sanwal *et al*., 2022). Consequently, climate change represents a great threat to obtaining the sustainable production of major commercial fruits (Gora *et al*., 2019). Both the researchers and the growers are very concerned about meeting customer preferences and ensuring inexpensive, sustained nutritional food security in such an environment.

Given the conditions, it may be possible to take advantage of the potential of underutilized crops to produce edible fruits that satisfy the local population's need for food and nutrition in certain growing locations. Investigating specific native fruit crops that are neglected yet resistant to certain climatic fluctuations and able to adapt to a variety of agro-climatic settings is crucial. These crops can be both biotic and abiotic. The native fruit crops have demonstrated greater environmental tolerance and are highly valued for their high nutritional content (Berwal et al., 2021). Nevertheless, there hasn't been much research done on how to use these underappreciated fruit species and build production techniques. Additional challenges to the organized cultivation of these neglected crops include the limited number of recognized varieties, the shortage of high-quality planting materials, and the absence of suitable cultivation and post-harvest management practices.

Arid regions contain numerous species of vegetation that produce edible fruits and food. About 19 of the approximately 30 plant species in the Indian

dry zone are important for horticulture and provide edible fruits (Rathore et al., 2009). These species are known for their various food purposes. In addition to being valuable sources of fresh fruit, many neglected fruit crops can also be used in cooking and medicine to provide essential nutrients. Some of these crops even have decorative qualities. The locals have knowledge of their nutritional and therapeutic qualities. In fact, compared to many commercial fruit crops, the majority of indigenous underused fruit crops, like ber, kair, aonla, lasora, and phalsa contain higher levels of phytonutrients, antioxidants, and minerals. These underutilized fruits are also not very popular and are sold in the local markets for extremely low prices due to (a) a lack of knowledge about their nutritional value, (b) ways of eating, (c) a lack of research, and (d) government agencies' developmental policies regarding their possible exploitation.

The Government of India, under its centrally sponsored scheme, i.e., Mission on Integrated Development of Horticulture (MIDH, then 'National Horticulture Mission', NHM) during 2005–2006, gave a special impetus to establish orchards of underutilized fruit species, given the significance of these tree crop species in traditional medicine, their wide adaptability and nutritional richness. This study examines the therapeutic benefits and agricultural methods of twenty underutilized fruit crops that are native to dry and semi-arid regions of India.

Medicinal significance of underutilized fruit plants

The majority of underutilized fruits have high nutritional benefits, and it is advised that you consume them in your regular diet. Because they are high in vitamins, minerals, and phytochemicals, they are frequently employed in the manufacture of several ayurvedic medications. The flavor and fragrance of these fruits are abundant. In addition to their nutritional, medicinal, and monetary worth, the variety of these fruits has cultural and social significance and supports the stability of the ecosystem. These crops' cultivation and consumption might aid in addressing the dietary deficits that are common in rural and tribal communities. They also help the nation's impoverished population's socioeconomic circumstances.

Apart from their economic, social and environmental benefits, these fruits possess various medical characteristics due to the pharmacological actions of their various plant sections. As a result, these fruits are abundant in vitamins, minerals, and phytochemicals that must be collected in order to commercialize them and use the waste land at the same time. Table 1 displays the biological activities of insufficiently utilized fruits.

Table 1: Underutilized, hot, semi-arid fruits' biological activity

Crop	Biological activities
Aonla	Neutraceutical and pharmacological properties, anti-fungal, antioxidant, anti-bacterial, anti-mutagenic, anti-viral, anti-inflammatory, anti-histaminic, immuno–modulatory, anti-hepatoxic, and hypolipidemic
Bael	Antidiabetic, cytotoxic, anticancer, antispasmodic, artiemicide, astringent, antibacterial, antihelminthic, antidiarrhea, sedative, antiallergic, hypnotic, analgesic, anticonvulsive, antiinflammatory, antiulcer, antiseptic, hypothermic, antimalarial, antipyretic, antidiuretic, antitumor, antidislipidemic, cardioactive, and antihyperglycemic
Jamun	Anorexigenic, antidiarrheal, ulcerogenic, anti-inflammatory, neuropsychopharmacological, antimicrobial, antibacterial, antifungal, gastroprotective, radioprotective, antifertility, antihyperglycemic, and anti-HIV
Custard apple	Hypoglycemic, anti-HIV, antiulcer, antiviral, antioxidant, respiratory stimulant, antimalarial, anti-inflammatory, anthelmintic, anti-arthritic, hepatoprotective, and analgesic
Mulberry	Anti-inflammatory, antidiabetes, anaemia, hypertension, arthritis, antioxidant, neuro-protective and antimicrobial
Wood apple	Antifungal, anti-bacterial, antimutagenic, diuretic, dysentry, indigestion and induce bowel boils and amoebiosis, and hypoglycemic
Tamarind	Gastric, hyperlipidemic, cardioprotective, fever, and jaundice
Khirni	Blood purifier, appetizer, jaundice, arthritis, asphrodisiac
Mahua	Antitumor, anti-inflammatory, opacity of the cornea, hematoprotective, analgesic, ulcer, dyspepsia, leprosy, bronchitis, and tonsillitis
Chironji	Rheumatic pains, anti-diarrhoea, skin diseases and intercostals
Phalsa	Antimicrobial, astringent, cardiac and blood disorders, stomachic, demulcent, rheumatism, radioprotective and antihyperglycemic properties, antiinflammation, administered in respiratory, anti-platelet, antiemetic, anti-cancer, and antioxidant

Karonda	Anti-helminthic, astringent, appetizer, antidiabetic, scabies, antipyretic, intestinal worms, antiscorbutic, diarrhoea and antipyretic
Manila tamarind	Abortifacient, peptic ulcers, astringent, larvicidal, dysentery, dyspepsia, earache, leprosy, sores, toothache, and venereal disease eczema, sore throat, acne and pimples
Wild noni	Antifungal, antiviral, antibacterial, analgesic, antitumor, anti-inflammatory, hypotensive, and immune enhancing effects.
Fig	Antidiarrheal, metabolic, diuretic, cardiovascular, antispasmodic, haemorrhage, respiratory, anti-inflammatory, antidiabetic, anthelmintic, tuberculosis, and anticancer
Gonda	Demulcent, diuretic, and anti-helminthic,
Timru	Antimalaria, antimicrobial, antidiabetic, and anti-plasmodial,

Chapter 2

Indian Jujube (*Ziziphus mauritiana* L.)

Description

Belonging to the Rhamnaceae family, ber is referred to as the poor man's apple or the king of arid-zone fruits. The ber tree grows quickly and has a short bole and spreading canopy. The branches have robust, brown, slender spines that are arranged in pairs (Meghwal *et al*, 2007). The ber tree is highly drought-resistant owig to its deep taproot system and xerophytic features, such as (a) dormancy (leaf shedding) during the hottest part of the summer to minimize transpiration, (b) waxy and hairy leaves, and (c) thick bark (Chundawat, 1990). It thrives even in marginal or nutrient-deficient soils where most other commercial fruit trees either struggle to grow or perform very poorly.

Distribution

Ber (*Zizyphus mauritiana* Lamk.) is a common and old fruit native to India. It grows in tropical and subtropical regions across the nation in wild, semiwild, and cultivated forms.

Health benefits of Indian Jujube

1. *Treatment of cancer*

While the precise processes and particular connections between Indian jujube and cancer are still being studied, preliminary findings indicate that the bioactive chemicals in Indian jujube are positively correlated with decreased activity of free radicals and the growth of cancerous cells. Indian jujube has antioxidants that make it a very efficient way to prevent chronic illnesses including heart disease and cancer.

2. ***Reducing blood pressure***

Potassium and vitamin B complex abound in Indian jujube and this is a tasty fruit that has been shown to significantly lower hypertension.

3. ***Health of skin***

Psoriasis, eczema, and acne are just a few of the skin irritations and inflammations that can be treated with Indian jujube juice and extract. To obtain many of the same effects, you can also eat jujube fruit. In addition to keeping the skin taut and stimulated with oxygenated blood, it can aid in the prevention of wrinkles and scars.

4. ***Treat digestive issues***

Indian jujube fruits are also linked to bettering the body's digestive systems. Its high fiber content is mostly responsible for this, but the saponins and triterpenoids also contribute by enhancing nutrient absorption and encouraging a healthy passage of food through the digestive tract. Constipation, cramps, bloating, and excessive flatulence, as well as more serious gastrointestinal disorders including colon cancer, can be prevented with this.

5. ***Skeletal strength***

Getting the right amount of minerals in your diet is one of the best strategies to build stronger bones. Increased levels of calcium, phosphorus and iron, all found in jujube, help to make sure that bones stay strong and resilient for many years to come. Osteoporosis and other problems causing bone degeneration are common as we age; however, you can halt or even reverse this tendency by incorporating Indian jujube fruit into your diet.

6. ***Boosting vitality***

The Indian jujube fruit is also a good energy source. Its powerful effects on the neurological system lessen weariness and aid in energy restoration.

7. ***Making the teeth, bones, and muscles stronger***

This fruit's strong calcium and phosphorus content help to strengthen teeth, bones, and muscles.

8. ***Blood purification***

Indian jujube fruit contains saponins and alkaloids that have been directly linked to blood purification and the removal of dangerous toxins from the body's systems. This antioxidant impact can lessen the pressure on the immunological and lymphatic systems and help to avoid a wide range of illnesses and conditions.

9. ***Rapid wound healing***

Ber fruit, which is rich in vital amino acids, aids in the synthesis of various proteins by body cells, which is necessary for the healing of wounds brought on by outside forces.

10. ***Weight management***

A popular recommendation for those trying to lose weight is to eat fruits and vegetables, and Indian jujube is another that can be readily added to that list. Indian jujube has a high protein and fiber content, low calorie count, and can fulfil your hunger and fullness so you don't have to snack between meals. By doing this, you may keep up your diet and avoid gaining more weight.

11. ***Anxiety and stress***

It has been demonstrated that Indian jujube has some calming and anxiolytic properties for the body. Utilizing the extract from Indian jujube trees or eating the fruits themselves can affect hormone levels and provide a feeling of calmness and relaxation in both body and mind. Snacking on some dried Indian jujube or taking a jujube supplement can help to calm the mind and shield the body from the harmful effects of prolonged exposure to stress hormones for those who experience chronic stress or anxiety on a regular basis.

12. ***Helps to relax the nervous system***

Indian jujube fruit functions as an antidepressant because of its relaxing effect on the neurological system. It aids in anxiety and stress relief. Insomnia and other sleeping disorders are also treated by it.

13. ***Boost your immunity***

Free radicals in the blood circulation system, which can lead to heart obstruction and numerous other cardiovascular issues, are naturally

captured by flavonoids. There are other flavonoids that have significant amounts of anti-inflammatory, anti-tumor, and antioxidant properties. These aid in the prevention of formation of cancer cells, treat a variety of digestive issues, lessen allergies, and ultimately boost immunity.

14. ***Therapy for insomnia***

Sleeplessness and restlessness may be effectively treated by ingesting the seeds of the Indian jujube fruit extract. Perhaps a little Indian jujube decoction could help you fall asleep at night if you find yourself restless during the night due to the calming properties of the chemical compounds in this health-promoting fruit.

15. ***Circulation problems***

Iron and phosphorus, which are essential components of red blood cells, are abundant in Indian jujube fruit. You may have symptoms including weariness, dyspepsia, lightheadedness, cognitive disorientation, and muscle weakness if you have anemia or low iron in your blood. Indian jujube fruit increases iron and phosphorus content, which increases blood flow and more efficiently oxygenates your extremities and organ systems, giving you a surge of energy.

Package of practices

Soil and Climate

Since the ber plant is hardy, it may thrive in environments with poor soil and unfavorable weather patterns where most other fruit trees cannot. For optimal cultivation, it demands a hot, dry climate; nevertheless, during its first fruiting season, it needs enough water. It can be grown up to a height of one thousand meters above mean sea level. Its successful fruiting appears to be restricted by excessive ambient humidity.

Deep sandy loam soils, on the other hand, seem to be more suitable for its plantations. It is widely renowned for its capacity to flourish in unfavorable salinity, drought, and waterlogging conditions.

Cultivars

i) Nazuk - Exhibits lower susceptibility to powdery mildew.

ii) ZG-2 - Displays reduced susceptibility to powdery mildew.

iii) Sanaur-2 - A mid-season variety that matures in the second half of March and has considerable resistance to powdery mildew.

iv) Sanaur-5 - A mid-season variety.

Rootstock and propagation

Until recently, seeds have been the most popular way to multiply ber plants. The ber seedling must be cultivated for the aim of serving as a root stock in order to propagate vegetatively. Typically, in March and April, 30 cm x 15 cm spacing is used to plant seeds of Katha ber (*Zizyphus mauritiana*) (after fresh extraction). Freshly harvested seeds can have their germination enhanced by immersing them in strong sulfuric acid for six minutes and then immediately giving them a thorough wash with water. Seeds that are one year old and kept at room temperature sprout more readily than seeds that are just removed.

Top working of wild trees

To reduce the possibility of the entire tree drying out, branches on mature trees should be pruned back to about 30 cm from the main branch, keeping the central limb untouched (these central limbs be cut off when the top worked limbs are established). From January through April, heading back operations can be completed. In June and July, the headed back trees grow several shoots below the cut end. Of these, two or three healthy, evenly spaced shoots should be kept, and the others should be destroyed. From June to September, these maintained shoots must be 'T' budded with any enhanced cultivar when they reach a thickness of 1.5 to 2.0 cm. For immature trees, the budded shoots can be piled, and for larger trees, they can be linked with central limbs to prevent breakage from wind risks. The top-worked trees grow to a suitable size in less than a year, and in the next two and three years, they begin to yield well.

Planting

For ber crop, there are two planting seasons: July–September and February–March. A month prior to planting, the ground is prepared and pits measuring 1 m x 1 m x 1 m are dug. Pits should be filled with soil that has been mixed with around 100 g of urea, 1 kg of super phosphate and 20 kg of well-rotten farmyard manure to a height of about 15 cm above the ground. After that, water should be poured into these pits to help the loose dirt settle. Maintaining the same soil level as when it was at the nursery, a plant should be placed in the middle of a pit. The developing union should stay between

15 and 20 cm above the surface. After the plants are fixed in the pits, they need to be watered right away. For the first two months, the plants should be watered every four to five days. After that, they should be watered once a week for the next three to four months, or until the plants are completely established. It is imperative that any branches that emerge below the budded point be plucked right away.

Training and Pruning

As soon as the tree is planted, training becomes crucial for it to create a robust framework. It is important to take precautions during training to ensure that no branch is lower than one meter from the main stem. There could be four to six major branches in total. The tree will be able to grow in a healthy, balanced shape as a result.

In order to preserve the vigor and productivity of trees and to enhance the quantity and quality of the fruit, pruning is highly desirable. On the young shoots of the current season, the fruits are carried in the leaf axil. Consequently, yearly trimming is required to encourage strong shoots, which will maximize the tree's fruit-bearing area. When plants shed their leaves and get ready to rest or enter dormancy, the hot and dry season is the ideal time to prune. It is preferable to lightly prune, or to head back of about 1/4 of the mature growth, in order to increase the output of high-quality fruit. To allow enough sunshine to reach the branches of ber trees and promote optimal aeration, some pruning of the branches is also required to prevent overcrowding.

Manure and Fertilizers

Tree age (Year)	**Farmyard manure (Kg/tree)**	**Fertilizer (g/tree)**		
		Urea	**Di-ammonium phosphate**	**Muriate of potash**
1	10	215	-	-
2	20	435	-	-
3	30	650	-	-
4	40	870	-	-
5 and onwards	50	1085	20	100

Irrigation

Ber can be cultivated effectively in arid climates, although for higher yields, budded trees do require watering. Bearing trees may receive one monthly irrigation at the time of fruiting. Irrigation should be avoided when the fruits are ready to ripen to prevent them from becoming overly soft and tasteless. If there isn't any rainfall after the fruit has been gathered, one or two irrigations can be sufficient.

Harvesting and yield

Mid-March to mid-April is the peak season, while actual harvest times may vary according on region, altitude, cultivar, etc. It can take three to five pickings because the fruits do not all ripen at the same time. When a cultivar reaches its prime producing age, its typical production varies between 80 and 200 kg of fruit for each tree. The yield is comparatively smaller in arid regions i.e., 50 to 80 kg per tree.

Plant Protection

Management of Insect Pest

Fruit Fly (*Carpomyia vesubiana*)

Ber fruit flies injure mature fruits, and maggots eat on the pulp, spoiling the fruit.

Management Practices

i. Harvest fruits when they are still hard.

ii. Collect and destroy all fallen fruits.

Diseases

Powdery mildew

The disease targets new leaves and fruit during their vulnerable stage. Symptoms initially appear as a white powdery coating on the leaves or in patches on the surface of the fruit. These spots eventually develop into light brown to dark brown discoloration. Affected leaves curl, and the fruits wilt and fall off.

Leaf Spots

On the foliage, spots of different sizes and shapes show up. A severe attack could cause the leaves to fall.

Chapter 3

Indian Gooseberry (*Emblica officinalis* G.)

This plant is a member of the Euphorbiaceae family and has been valued in India since ancient times for its medicinal and therapeutic qualities. Recognized as one of the significant native fruits of the Indian subcontinent, it is widely utilized in traditional Indian medicine and is commonly referred to as aonla or amla.

Description

Aonla fruits are round, ribbed, and have a pale green color. They are divided into six segments with subtle linear grooves, and a glossy surface. Fruit size ranges from a small marble to a large plum, and the skin is thin and somewhat translucent over the firm flesh. Due to its high acidity and astringent taste, the raw fruit is generally unappealing to consumers. The average fruit weight for cultivars such as Krishna, NA7, and Chakaiya ranges from 22.29 to 25.20 grams, while the seed weight varies between 1.54 and 1.82 grams (Goyal *et al*., 2009).

Health benefits of Indian gooseberry

Gooseberries are a wealth of high-quality, reasonably priced fruit with a host of health advantages. Here are some health advantages of gooseberries:

1. Anticancer

Gooseberries are rich in phytochemicals that prevent the growth of cancer cells, including flavonoids like quercetin and kaempferol and their glycosides, and tannins like pyrogallol, chebulagic acid, and gallic acid. These substances encourage apoptosis. Additionally, it guards against lung cancer, leukemia, breast, prostate, and colon cancer.

2. ***Anti-inflammatory***

The key components of Indian gooseberry health advantages include polyphenols, tannins, and ascorbic acid, which block an enzyme linked to inflammatory disorders. Gooseberry also contains gallic acid, ellagic acid, and emblicanin A and B, which have antiulcer properties. Consequently, gooseberry has potential use as a natural anti-inflammatory medication and for the management of neuropathic and postoperative pain.

3. ***High in antioxidants***

High concentrations of rutin, quercetin, and other phenolic compounds are found in gooseberries. They aid in scavenging free radicals and shielding vital organs from harm. Gooseberries can therefore function as potent free radical scavengers, halting the advancement of numerous illnesses linked to oxidative stress.

4. ***Management of diabetes***

Gooseberry polyphenols, such as gallic acid, gallotannin, ellagic acid, and corilagin, as well as tannins and flavonoids, such as quercetin, have the potential to lower blood sugar levels without causing weight gain.

5. ***Heart-friendly***

The abundance of polyphenol, pectin, dietary fiber, and tannins found in gooseberries helps to reduce blood pressure, triglycerides, and platelet aggregation. Therefore, consuming these antioxidants lowers the chance of developing atherosclerosis and heart disease

6. ***Healthy liver***

Gooseberry contains quercetin, gallic acid, corilagin, and ellagic acid which acts as an adjuvant for liver damage. Therefore, the gooseberry consumption helpful to detoxify the toxic material from the body and for hepatoprotective activity.

7. ***Memory enhancer***

A good source of antioxidants, gooseberries can help treat dementia, Alzheimer's disease, and other neurodegenerative diseases by acting as a natural memory enhancer.

8. ***Treats heavy metal toxicity***

One of the main sources of arsenic pollution that harms people's health is contaminated groundwater. Gooseberries are rich in antioxidants that scavenge free radicals produced by arsenic. While they may not directly prevent the deposition of arsenic in tissue, gooseberries can be utilized as a therapeutic agent to guard against toxicity caused by arsenic.

Gooseberry also helps to prevent oxidative damage caused by chromium (which is very cytotoxic) by increasing cell lifespan and reducing the generation of free radicals.

9. ***Blindness protection***

One of the conditions associated with age-related macular degeneration (AMD) is blindness. Antioxidants like β-glucogallin found in gooseberries, when supplemented, may reduce the risk of diabetes complications such cataracts and age-related macular degeneration.

10. ***Lowers hypertension***

A gooseberry's high vitamin C content, cytokine-like compounds including zeatin, Z-nucleotide, Z-riboside, pectin, flavonoids, and tannins may help lower blood pressure and minimize the risk of stroke in hypertensive individuals.

11. ***Maintains stomach health***

Antioxidant and radical scavenging properties of gooseberries may offer protection against ulcers, tissue damage, inflammatory bowel diseases (IBDs), primarily ulcerative colitis (UC) and Crohn's disease (CD), and other gastrointestinal tract disorders.

12. ***Lustrous, healthy hair***

Vitamin C and polyphenolic chemicals found in gooseberries activate Dermal Papilla (DP) cells, which in turn promotes the growth of hair.

Additionally, amla oil is utilized to fortify and encourage the growth of hair. Additionally essential to shampoo and hair oil, dried amla powder can be used as a hair tonic to enhance pigmentation and hair development.

13. ***Glowing skin***

Vitamin C, minerals, amino acids, and other phenolic chemicals are all abundant in gooseberries. These are superior antioxidants that shield human dermal fibroblasts from oxidative stress by promoting the synthesis of procollagen. Amla can therefore be used to prevent or delay the appearance of aging in both medicinal and cosmetic contexts.

14. ***Improve sperm quality***

Gooseberry leaf (50 mg/kg) is a good source of antioxidants, including tannins, saponins, and other phenolic compounds. These antioxidants are beneficial for reducing stress, enhancing sperm motility, improving sperm quality, and restoring vigor and vitality that has been lost.

15. ***Treats pneumonia***

High levels of vitamin C and flavonoids found in gooseberry, guard against infection and bacterial colonization in the respiratory system brought on by Klebsiella pneumonia.

16. ***Strengthens bones***

Gooseberries are rich in phytochemicals that effectively scavenge free radicals, including gallic acid, ellagic acid, and emblicanin A and B. These substances trigger the primary osteoclasts in humans to undergo programmed cell death, which is used to treat osteoporosis and rheumatoid arthritis.

17. ***Treat early stage of HIV infection***

Antioxidants found in gooseberries have anti-HIV properties and may prevent the early phases of the HIV replicative cycle, making them a valuable treatment for HIV infection.

18. ***Antipyretic properties***

Gooseberries possess several substances, including alkaloids, tannins, phenolic compounds, carbohydrates, and amino acids, which are accountable for their antipyretic effect.

19. ***Analgesic properties***

Gooseberries contain alkaloids, tannins, phenolic chemicals, carbohydrates, and amino acids, which contribute to their analgesic properties.

20. ***Healthy oral***

Gooseberry has antibacterial characteristics due to the presence of tannins and flavonoids. It also functions as a herbal mouthwash and has the ability to raise salivary pH, buffer, and inhibit Lactobacilli and S. mutans.

Package of practices

Its high vitamin C content is what makes it important. Its hardiness makes it appropriate for subtropical wastelands.

Climate and Soil

It is not greatly affected by frost or severe winds. Nevertheless, young plants need to be safeguarded from cold winter temperatures and drying summer breezes until they are at least three or four years old.

Aonla can be grown in both heavy and light soils, with the exception of very sandy soils. The plants can grow in soils that are somewhat alkaline as well as regions that receive rain. However, rich, deep loamy soils produce a lot of it.

Varieties

Some of the Aonla varieties are:

i. NA7: Francis's choice seedling. It is a regular, prolific, and precocious bearer. This type is perfect for processing.

ii. Banarasi: This tree grows erect and is a timid bearer. The flesh has almost no fibers and is very slightly fibrous.

iii. Francis: The branches bear moderately and exhibit a drooping character. Soft and almost fiberless flesh.

iv. Chakaiya: This tree bears abundantly and has a spreading habit. Hard and fibrous flesh.

v. NA4 (Krishna): Moderate yielding. Flesh is firm, semi-transparent, and fiberless.

vi. NA6: An assortment of Chakaiya seedlings. It bears heavy and in large quantities. Because of its low fiber content, it is perfect for candies and preserves.

Propagation and Rootstock

It can be grown from seeds; however, the plants fail to develop according to the seed and provide little, low-quality fruits. Raised from seeds, seedlings serve as rootstock. It takes four months for seedlings grown in polythene bags or seedbeds to reach buddable size.

Shield budding and patch budding are the most popular asexual propagation techniques during the month of August.

Planting

The best planting time for grafts or budded plants of Aonla is July-August. A spacing of 8-10 meters in both directions (between rows and between plants) is recommended, as a considerable size can be attained by the trees. Planting is best performed in the spring (February – March) in regions where irrigation access is available. Each plant should receive light irrigation immediately after planting.

Training and Pruning

Regular pruning is not required by aonla tree. However, to ensure proper shaping and the development of a strong framework, pruning may be necessary during the early years. The tree should be trained to maintain a single stem up to a height of about 1 meter, after which primary branches can be allowed to grow at regular intervals around the trunk.

After the crop is harvested each year, pruning of the bearing plants can be performed. During this process, weak, dead, broken, diseased, and crossing branches, as well as suckers emerging from the rootstock, should be removed.

Manure and Fertilizers

FYM should be given in quantity of 15 to 20 kg to young trees and 30 to 40 kg to matured trees. In addition, 1.1 kg DAP, 1.8 kg urea and 1.7 kg MOP should be applied to every mature tree (10 years old). During January, the

full dose of DAP and FYM along with half of urea and MOP should be applied in the tree basin and the remaining half should be given in August. Additionally, 100-150g of boron and $ZnSO_4$ should be applied in sodic soils along with the fertilizers.

Irrigation

Hardly any irrigation is practiced in aonla trees because these are hardy and stand very well against drought. Nonetheless, the crop will benefit from two to three irrigations during fruit set and full bloom. Irrigating trees in the summertime may not be beneficial because the trees are dormant. However, until they are completely established, new plants need to be watered every two weeks during the summer.

Harvesting and Yield

Aonla plants take a long time to fruit. While seedling trees may take 8–10 years to give fruit, commercially grown trees often begin to yield after 3–4 years of planting. According to estimates, trees have a 50–60 years productive life under ideal management circumstances. When a seed turns from creamy-white to brown, it means the fruit is mature. Mature fruits have the highest level of vitamin C, while immature fruits are acidic and have lower levels of minerals and vitamin C.

Aonla crop yield differs amongst cultivars. Regarding yield, cultivar-to-cultivar variations exist in production. The Banarasi cultivar yields less than NA7 and Chakaiya. A mature tree produces 150 to 200 kg of fruits annually on average.

Plant Protection

Management of insect pests

1. Aonla fruit borer (*Deudorix isocrates*)

After a harvest, plants have mummified fruits because the larvae have eaten through the fruit and fed on its pulp.

Management Practices

i. Eliminate and dispose of all impacted fruits.

ii. Fruit bagging is another useful method.

2. Aonla gall maker (*Betousa stylophora*)

Branches should not be overcrowded and should be clipped.

3. Bark-eating caterpillar (*Indarbela quadrinotata*)

The larvae consume the bark from the branches and stems. These trees have chewed wood, excretal pellets, chips, and ribbon-like webbings that the caterpillar moves and feeds on. The infected trees exhibit a decline in vigor and vitality and may eventually perish.

i) Maintain a clean orchard

ii) Steer clear of cultivating vulnerable kinds.

iii) Use mud plaster to plug the gaps.

Diseases and their management

1. Rust (*Ravenelia emblicae*)

A greater region is covered by a ring formed by the subsequent joining of black pustules. Ruptures of pustules reveal a mound of black spores. On leaves, pinkish pustules may appear singly or in clusters.

2. Anthracnose (*Colletotrichum spp*.)

On leaflets, there are tiny, round, grayish spots with yellow borders; the center part of the leaflet stays gray and has fruit bodies that resemble dots. Fruit lesions are low, darken in the center, and create acervuli that are organized in circles. Lesions can differ in dimensions and form. When humidity is high, spore mass appears on fruiting bodies. Fruits that are infected shrivel and decay.

3. Fruit rot (*Phomaspp*., *Phomopsis phyllanthi, Cytospora spp*., *Cladosporium tenuissimum, Nigrospora spheaerica, Alternaria alternate, Pestalotia, creenta,*)

The illness manifests as tiny, necrotic, pinkish-brown patches. Fruit may partially or completely decay when smokey brown to black spherical lesions, black ring marks, or colorless mushy regions show up.

4. Blue mold rot (*Penicillium islandicum*)

Fruit develops brown patches with wet spots as a result of it. Three distinct colors— bluish green, purple brown, and bright yellow—develop as the illness worsens. The fruit eventually takes on a blue grey or beaded appearance, releases a foul odor, and produces yellowish liquid droplets from the diseased areas.

Techniques of management

i) Take care when handling fruit to prevent cuts.

ii) Maintain hygienic storage conditions.

Chapter 4

Lasora (*Cordia myxa* L.)

Description

Lasora (*Cordia myxa* L.) belongs to Boraginaceae family. The cordia tree grows quickly and is used as an avenue tree and ornamental furniture. Its ovate, alternate, and stalked leaves are used as fodder in the hot summer months when green grasses are scarce, and they are also used to rear lac insects (Ahuja et al, 2020; Reddy et al, 2019). Trees grow drupaceous green, immature fruit that is ready to be harvested in April and June, as well as white hermaphrodite flowers in March. Most commonly, it is utilized as pickles and fresh green vegetables, particularly during the lean season when conventional vegetable availability is restricted (Bhatnagar et al, 2016).

Distribution

Except for the high highlands and the temperate regions, Cordia—also referred to locally as Gonda, Lehsua, Lasora, Assyrian plum, Indian cherry, or bird's nest tree—is planted across India (Stewart and Brandis, 1992).

Health benefits of lasora

1. *Cold and cough*

Due to their strong anti-inflammatory qualities, glueberries are good for cough, colds, and chest congestion. Because of the mucilaginous pulp, eating this fruit may help reduce the symptoms of a cough. The fruit's mucilaginous pulp, which is high in "sterol," relieves discomfort, sore throats, coughs, and fevers.

2. *Skin infection*

Applying the mucilaginous pulp paste of ripe glueberries or their leaves can be used to cure bites from tsetse flies, ringworm, and trypanosomiasis. Moreover, taking it orally can aid in the prevention of skin conditions.

3. *High blood pressure*

The most common disease worldwide is hypertension. The fruit of Cordia myxa possesses anti-hypertensive qualities. Fruit extract lowers oxidative stress and regulates blood pressure. Fruit extracts, both ripe and unripe, can reduce blood pressure.

4. *Antidiabetic*

For those with diabetes, it is really helpful. These fruits contain some compounds that have diuretic and anti-diabetic actions.

5. *Liver diseases*

This fruit is excellent for supporting the liver.

6. *Anti-ulcer benefits*

Glueberries have qualities that help shield the stomach from developing ulcers. It has a few necessary components that can prevent stomach ulcers.

7. *Arthritis and joint pain*

The anti-inflammatory and analgesic qualities of glueberries' fruits and leaves help lessen joint discomfort and inflammation.

Package of practices

With the exception of steep hills, Lasora is a, broad-leaved, medium-sized deciduous tree that is spread throughout India. It is widely distributed in semi-arid and rainfed regions of North India due to its exceptional ability to withstand drought once it is established.

Climate and Soil

It may grow up to 5,000 feet above sea level in both subtropical and tropical environments. It can tolerate dryness to a large extent, but it requires a warmer temperature and is vulnerable to frost. In sub-tropical zones, temperature is the crucial factor in flowering, whereas in tropical zones, moisture availability can control flowering. Lasora requires relatively little in the way of soil, and it can grow well under conditions when it is salinized or lacks water.

Varieties

As it has been cultivated from seeds, distinct varieties do not exist. Nonetheless, there is a lot of variation in the pulp content and fruit size.

Propagation

Usually, seeds are used to spread it. In April and May, seeds are taken from recently picked, ripe fruits and sown. July to August is when the plants are ready to be planted. On seedlings that are a year old, budding can be done successfully from July to September.

Planting

In rain-fed environments, the best time to plant is at the start of the rainy season. 60 cm x 60 cm holes should be dug 6 m x 6 m apart in the summer. At least one month prior to planting, these pits are replenished with farmyard manure and soil in the ratio of 1:1. It is best to build a small catchment area around every plant so that runoff can be collected during the rains.

Training and pruning

Initially, young plants are trained to stand upright. While it's not necessary to prune, sick and dead branches should be removed.

Manure and Fertilizers

Fertilization is necessary for healthy, consistent output. At the onset of monsoon, each tree should be provided with 600 g of urea and 25 kg FYM.

Irrigation

For new seedlings to establish themselves, irrigation is necessary if the monsoon fails during the planting year. This plant doesn't need irrigation after it reaches this point.

Blooming

In its fourth year, a grafted or budded plant bears fruit, with flowering occurring in March or April. In May or June, the fruit ripens.