Chapter

3

Soil and Climate for Horticultural Crops

INTRODUCTION

Soil is the loose surface layer that covers the majority of the land. It is made up of both inorganic and organic particles. Soil gives structural support to horticultural plants as well as being a source of water and nutrients. Soil is technically a mixture of minerals, organic substances, and living organisms. Soils vary greatly in their chemical and physical properties. Leaching, weathering, and microbiological activity all work together to create a wide range of soil types. Each type has distinct advantages and disadvantages in agricultural output. Each species of fruit plant has a rarely well-defined temperature range that it can withstand and beyond which the plants may suffer injury. In actuality, climate refers to the typical weather that prevails over a wide region. The main components of climate are wind, sunlight, rainfall, temperature, and relative humidity.

SOIL

There are numerous varieties of soil found throughout the world, which are broadly categorized as follows **(Fig 3.1)**:

- **Clay soil:** Among the other two types of soil, i.e. sandy and silt, clay has the smallest particle size. The particles in this soil are firmly packed together, with little or no airspace between them. This soil has excellent water storage capabilities, making it difficult for moisture and air to infiltrate. When wet, it is incredibly sticky to the touch, but when dry, it is smooth. Clay is the densest and heaviest type of soil because it does not drain properly or allow plant roots to grow.
- **Sandy soil:** Sand is the initial type of soil. It is made up of little pieces of worn rock. Sandy soils are among the worst types of soil for growing plants because they have very few nutrients and a limited water-holding capacity, making it difficult for the plant's roots to absorb water. This sort of soil is ideal for drainage systems. Sandy soil is typically created as a result of the break down or fragmentation of rocks such as granite,limestone, and quartz.

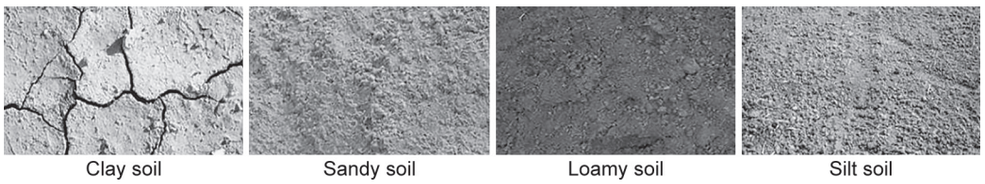

Fig. 3.1: Different soil types *(For colour version see Plate 1)*

- **Loamy soil:** It is a blend of sand, silt, and clay that in corporate the positive features of each. For example, it can retain moisture and nutrients, making it ideal for farming. This soil is also known as agricultural soil since it contains an equilibrium of all three types of soil components, namely sandy, clay, and silt, as well as humus. Because of its inorganic origin, it also has greater calcium and pH levels.
- **Silt soil:** Silt is composed of rock and other mineral particles that are smaller than sand but larger than clay, and it has much smaller particles than sandy soil. The smooth and fine texture of the soil holds water better than sand. Silt is easily transported by moving currents and is most commonly found near rivers, lakes, and other bodies of water. When compared to the other three types of soil, silty soil is the most fertile. As a result, it's also employed in agricultural activities to boost soil fertility.

Soil is typically composed of four elements, i.e. inorganic or mineral fraction, organic matter, air and water. Furthermore, soil serves a variety of critical roles, including:

- Providing a medium for plant growth.
- It modifies the Earth's atmosphere.
- One of the most important biosphere components
- It serves as a habitat for organisms.

Soil Profile

The soil profile is a vertical cross-section of the soil that is made up of layers that are parallel to the surface.The horizon refers to the diverse textures of the soil layers.

Horizon A (top soil): This is the topmost layer, where organic materials have merged with mineral matter, nutrients, and water which are required for plant growth.

Horizon B (subsoil): This zone contains a higher concentration of minerals and less humus. It indicates a transition between horizons A and C and contains stuff from both below and above.

Horizon C (weathered and decomposed rock): The loose parent rock material makes up this zone. This layer is the first stage in the creation of soil. The rock known as the parent rock or the bed rock lies under neath these three horizons.

Composition of Soil

The soil is made up of several components, including 5% organic matter, 45% minerals, 20–30% different gases, and 20–30% water. As a result, soil is classified as a heterogenous body. The soil's composition is detailed below.

Organic Matter

Organic substances are found in trace quantities in soil. Organic matter is primarily derived from plants and animals. Organic matter is classified into three kinds based on its decomposition stage.

Minerals

Minerals are an important element of the soil. These are solid components composed of atoms. These occur naturally and have a fixed chemical composition. Olivine and feldspar are the main minerals present in the soil.

Gaseous Component

The gaseous components are found in the soil's air-filled pores. The nitrogen and oxygen present in the pores are often fixed by microbes from the ambient air. However, the carbon dioxide composition is higher due to the gas produced by soil microorganisms.

Water

The soil dissolves minerals and nutrients in water and serves as a source of nutrients pool to the plants. These are required for the plant's growth and development.

Functions of Soil

Soils have three critical roles in the global ecology. Soil is used as the following:

As Medium for Plant Growth

Soil provides a suitable environment for plants by acting as an anchor for plant roots and a water-holding tank for moisture. Soil texture (coarse or fine), particle size, porosity, aeration (permeability), and water-holding capacity are some of the soil qualities that influence plant growth. Soil has a crucial role in storing and supplying nutrients to plants. A soil's fertility is directly influenced by its clay and organic matter composition. Greater clay and organic matter content will generally result in greater soil fertility.

As Regulator of Water Supplies

When rain or snow falls on the ground, the soil absorbs and stores the moisture for later use. Water travels downward through the soil profile when soils are very wet, near saturation unless it is brought back to the surface by evaporation and plant transpiration. The quantity of water a soil can hold against gravity is referred to as its water-holding capacity (WHC). This property is closely related to the number of extremely small micropores present in the soil as a result of capillary effects.

Organic matter improves the ability of all soils to retain water while also increasing the infiltration rates of fine-textured soils.

As Recycler of Raw Materials

As a recycler of raw materials, soil serves one of the most important roles in global ecology. The decomposition of dead plants, animals, and organisms by soil flora and fauna (e.g. bacteria, fungi, and insects) converts their remnants into simpler mineral forms, which are subsequently used by other living plants, animals, and microbes to create new living tissues and soil humus. Soil organic carbon has been identified as a crucial element in maintaining the global carbon cycle's balance. Land management strategies that influence soil organic matter levels have been extensively researched and are frequently recognized as potentially influencing the occurrence of global climate change.

The other functions are as follows:

- A wide range of species, such as earthworms and decomposers, find refuge in the soil. These microorganisms improve soil fertility.
- Beneficial microorganisms in soil are vital to plants because they aid in the recycling of nutrients such as nitrogen, phosphorus, and potassium.

The ideal soil for horticulture crops should possess the following characteristics:

- It should be fertile and well-drained.
- Soil should be sufficiently deep, especially for fruits.
- The water table depth should be 4 m from ground level.
- It should be retentive for nutrients and water.
- In reaction, soil should be neutral with a pH range of 6.5–7.5.
- It should be free from high salt concentration and underlying pan.

CLIMATE

The climate is an important influencing factor in agriculture. Unlike "weather," the term"climate" indicates the atmospheric conditions that can be expected over a lengthy period. On the other hand, "weather" refers to the discernible, short-term atmospheric conditions at a specific spot on the planet. Essentially, the climate determines which crops may be grown in the open air. It also has implications for livestock farming. In a nutshell, the climate influences what sorts of land uses are conceivable. Precipitation, temperature, and sunlight are the most influential climate elements. These have a direct impact on orchard plants. The farming climate, particularly in arable farming, can occasionally generate favourable development circumstances for pests and diseases. Alternatively, it may cause drought stress, which might make plants more susceptible to physiological disorders. This alone indicates the importance of climate in agricultural crop cultivation.

A region's climate is primarily determined by the following factors:
(a) Latitude, (b) altitude, (c) topography, (d) position relative to continents and seas, and (e) large-scale atmospheric circulation patterns. Almost every aspect of the climate has an impact on horticultural crops. All of them are inextricably linked. All crops have natural climatic threshold limitations beyond which they do not grow normally, but breeding and selection are rapidly raising the barrier for many crops. Depending upon the prevalence of various factors, the climate is broadly classified into temperate, subtropical, and tropical types.

Temperate: It has moderate rainfall spread out over the year or portion of the year, with periodic drought, mild-to-warm summers, and chilly-to-cold winters. Snow covers the regions in such a climate for 3–5 months of the year. During the summer, the temperature ranges from 10 to 14°C, with a relative humidity of 80–100%. This type of climate can be found between 1800 and 3500 metres above sea level. Fruit crops such as apples, pear, almond, cherry, plum, walnut, etc., vegetables like cole crops, root crops, peas, etc. and flowers like roses, gladiolus, orchids, lilies, etc. can be grown in such conditions.

Subtropical: A climate zone known as the subtropical climate is characterized by hot, humid summers and mild to chilly winters. They are noted for having hot summers and chilly winters. There is less rainfall in this sort of environment. The relative humidity is 80–100%, while the temperature is between 25 and 30ºC. The majority of it can be found between 900 and 1800 metres above sea level. Citrus, phalsa, fig, guava, and other fruits can be grown in such type of climate, it is easy to produce vegetables like peas, beans, cucumbers, tomatoes, etc. as well as flowers like roses, chrysanthemums, tuberoses, and jasmine.

Tropical: There are no clearly defined summer or winter days in such an environment. Such a climate is characterized by hot, muggy summers and moderate winters. Temperature differences between day and night are hardly noticeable. Both the rainfall and humidity are extremely high in this sort of environment. Seldom do temperatures get beyond 35°C. It occurs between 300 and 900 metres above sea level, and this type of climate is primarily found in the country's south (coastal regions). In this type of environment, you can find fruits like mango, banana, and papaya; plantation crops like coconut, tea, coffee, and rubber; vegetables like sweet potato, curry leaves, ginger, and pumpkin; and flowers like tuberose, gladiolus, and jasmine.

The following is a brief overview of key climate factors influencing horticultural crop production.

TEMPERATURE

One of the most essential aspects of climate is temperature. It is essential in the production of horticulture crops. Plant activities such as growth and development, respiration, photosynthesis, transpiration, nutrient and water uptake, reproduction (such as pollen viability, blossom fertilization, fruit set, and so on), carbohydrate and growth regulator balance, rate of maturation and senescence, and the quality, yield, and shelf life of edible products are all considered. Under optimum temperature conditions, all the physiological and biochemical functions of plants are normal. However, under high temperatures, the plant does not perform proper growth functions, whereas under low temperatures, the plant's physiological activities are stopped.

Specific trees are planted in different locations based on the temperature range; for example, apples, pears, peaches, and almonds are successfully grown in low-temperature regions known as temperate regions. Fruit trees in warm winter settings fail to finish their physiological rest period or achieve their chilling needs due to insufficient chilling temperatures. As a result, the buds remain dormant and the trees do not sprout leaves or blossoms the following spring. As a result, temperate fruit crops such as apples, apricots, pears, and plums are not regarded as ideal for cultivation in tropical or subtropical climates. The minimum temperature for tropical and subtropical fruits must be within the species' tolerance limit.

In the ideal temperature range, the plant performs effectively. Extremely high or extremely low temperatures have an impact on the plant's activity. The different plant's temperature ranges are:

- Minimum 4.5–6.5°C (40–43°F)
- Optimum 24–27°C (75–80°F)
- Maximum 29.5–45.4°C (85–114°F)

Effect of High Temperature

High temperatures can alter particular processes in horticultural plants, such as growth, flowering, fruit set and development, maturity and ripening, and abscission and senescence. High temperatures cause alterations in membrane-based processes such as photosynthesis and respiration, leading to the formation of reactive oxygen species.

Growth

High temperatures can inhibit growth during the seedling stage because the temperature close to the soil can be very high due to a boundary layer of air on

the soil surface. When the sun shines brightly, the temperature of the soil might rise to 50°C.

Flowering and Pollen Viability

Flower bud differentiation in many fruit trees is altered by high temperatures. Perfect flowers in mango plants are only possible in South Indian conditions when the maximum and minimum temperature ranges are between 29.5 and 21.6°C, respectively, whereas in North Indian conditions, the temperatures are between 39 and 20.2°C, respectively, and it is reported to be unsuitable for perfect flower development. At higher temperatures, citrus species experience a 70–90% decline in bloom. Pollen viability in various fruit plants, including mango, decreased to 85–60% when temperatures rose from 33 to 36°C during microsporogenesis. A cool and dry period, typically in winter, is essential for inducing flowering, as it slows or stops vegetative growth. Low temperatures (4–11°C), high humidity (>80%), and cloudy weather in January delayed panicle emergence. Additionally, the temperatures during inflorescence development reduced the number of perfect flowers.

Fruit Set and Development

At very high temperatures, the stigma and stigmatic fluid dry out before pollination, which can lead to pollination occurring without fertilization and negatively affect the fruit set. For instance, in Punjab, sapota becomes unfruitful under these conditions. Grape berries thicken, and anthocyanin buildup occurs at temperatures above 46°C. In mango, parthenocarpic fruits develop when the temperature reaches 44°C.

Apple fruit set is reduced due to high heat stress during panicle development, primarily because of pollen desiccation and decreased effectiveness of pollinator activity.

Maturity and Ripening

Mango sunburn is commonly observed when temperatures exceed 35°C during fruit maturation. For every 1°C increase in the mean temperature during June, July, and August, Cox apple harvesting advances by 3.5 days.

Preventive Measures

- Windbreaks that grow thick and tall must be placed when an orchard is first established.
- Avoid severely trimming trees throughout the summer.
- Before high temperatures start, take protective measures.
- At the start of the summer season, white wash the main stem, minor branches, and young plant shoots.
- To increase the humidity in the orchard, irrigate properly.
- Practice mulching in both young and old trees.
- Use of anti-transparent and water-soluble potassium fertilizers as spray.

Effect of Low Temperature

Low temperatures disturb several aspects of crop growth, *viz.*, survival, cell division, photosynthesis, water transport, growth, and finally yield**.** If the plants grown at high temperatures are exposed to low temperatures, they will be killed or severely injured.

There are many effects of low temperature, i.e.

- **Desiccation:** Imbalance between absorption rate and transpiration rate.
- **Chilling injury:** There is a disturbance in metabolic and physiological processes.
- **Freezing injury**: This phenomenon is termed "under-cooling protoplasm coagulation." Freezing injury occurs when ice crystals form within the tissue, although some species are more likely to recover from freezing and thawing than others.

Preventive Measures

- Delicate young fruit plants are placed in the orchard's interior.
- Windbreaks should be planted on the west and north sides of the orchard in due course.
- Add appropriate manures and fertilizers to strengthen and harden the plants.
- Frost-tolerant types are given priority for planting in the new orchard.
- Irrigate orchards regularly during frost times.
- In orchards, burndry leaves and twigs (10–12 places per hectare).

HUMIDITY

The amount of moisture required to create a fruit crop is heavily influenced by atmospheric humidity. Excess water is lost by transpiration in hot, dry weather. If the environment is humid, even though it is hot, the amount is significantly smaller, so a location in the humid zone requires less irrigation. High humidity and temperature also promote rapid development, increased production but increased insect and disease incidence. The water demand of a plant is also affected by humidity; however, the water requirements of different plant species vary. For example, 25 L of water were required to generate 1 kg of dry matter pine tree, 250 L of water for an apple, and 500 L of water for lucerne. Whereas, in plants under low humidity, the transpiration will increase causing water deficits in the plant. Water deficits cause partial or full closure of stomata and increase mesophyll resistance, blocking the entry of carbon dioxide.

LIGHT

Light is one of the most important factors affecting the plant's life. It is an integral part of the photosynthetic reaction in that it provides the energy for the combination of carbon dioxide (CO_2) and water (H_2O) in the green cells having chlorophyll for the formation of carbohydrates with the release of oxygen. The following equation is to explain the oxidation of water in photosynthesis.

$$CO_2 + 2H_2O \longrightarrow CH_3O + H_2O + O_2$$

$$6CO_2 + 13H \xrightarrow[\text{Chlorophyll}]{\text{Light radiation energy}} C_6H_{12}O_6 + 6H_2O + 6CO_2$$

The performance of crop growth of plants is influenced by three aspects of light (a) quantity of light, (b) intensity of light and (c) duration of light.

WIND

The effect of high winds on crops can be appreciable. Complete physical destruction may result because little can stand against winds of the order of 100 km/hour; even

large trees become uprooted. Some crops have quite low damage even with high wind speeds. In many regions, high winds can destroy the flowers, fruits, etc. Windbreaks can help reduce this problem. The windbreak trees, like *Eucalyptus* and *Acacia Casuarina*, are growing around the orchard for protection.

SOIL AND CLIMATIC CONDITIONS FOR DIFFERENT HORTICULTURAL CROPS

Fruit Crops

Mango

Soil: Mango can grow in all types of soil with good depth, i.e. 180 cm, and drainage except black cotton soil. The optimum pH requirement is 5.5–7.0. Alluvial and lateritic soil is ideal. It can tolerate saline conditions and cannot resist deficiency of potassium.

Climate: Mango may be grown from sea level to 1400 metres altitude in both tropical and subtropical climates, as long as there is no high humidity, rain, or frost during the flowering time. Mango cultivation thrives in areas with high rainfall and dry summers. It is best to avoid places where winds and cyclones can cause blossom fruit shedding and branch breaking.

Banana

Soil: Deep loamy soil with a pH between 6.5 and 7.5 is ideal for banana growing. Banana soil should have appropriate drainage, fertility, and moisture. Saline solid, and calcareous soils are unsuitable for banana growth. It thrives in soil that is neither too acidic nor too alkaline, is rich in organic matter, has a high nitrogen content, adequate phosphorus, and sufficient potash.

Climate: Banana, a tropical crop, thrives in temperatures ranging from 15 to 35ºC with relative humidity levels ranging from 75–85%. It grows from sea level to a height of 2000 m and likes tropical, damp lowlands.

Citrus

Soil: Its cultivation requires well-drained loamy soil with a homogeneous texture up to a depth of 2–3 metres and adequate fertility. The plant is extremely susceptible to waterlogging. Heavy soils, if adequately drained, produce good crops, but cultivation is laborious. A pH of 6.5–7.5 is optimum. The water table should not rise any closer than one metre above ground level. A high-water table and low-level sites are not suitable for either permanent or fluctuating nature.

Climate: Citrus plants thrive in tropical and subtropical regions and may tolerate minor frosts on occasion. The ideal temperature for healthy growth is between 16 and 20ºC. Citrus can drive at elevations ranging from 500 to 1000 metres. It grows well in arid places with 500 mm of rainfall and in mountainous areas with 2500 mm of rainfall. Loose-jacketed oranges like slightly higher elevations and tracts with higher humidity. Mandarins prefer humid, tropical summers with warm winters and heavy rainfall. Nonetheless, Nagpur mandarins can be grown effectively in desert-irrigated settings in central India. Limes and lemons thrive well in warm, somewhat damp circumstances.

Papaya

Soil: To avoid collar rot disease, well-drained soils with a homogeneous texture are preferred. Plants grow best in sandy loam soil with a pH range of 6.5–7.

Climate: Papaya thrives in a sunny, warm, and humid atmosphere. The plant can be grown up to 1000 metres above sea level, however, it cannot endure freezing. The ideal temperature for papaya is between 25 and 30ºC.

Guava

Soil: Guavas grow well in any soil type, although they produce best in rich soils with high inorganic matter. They also prefer well-drained soil with a pH of 5–7. Although good drainage is advised, guavas have been observed growing spontaneously on the ground with a high-water table too wet for most other fruit trees but not tolerant of saline soils.

Climate: Guava can be grown well in tropical and subtropical climates. Although guava tolerates drought, it requires protective irrigation facilities. It grows best when the yearly rainfall is restricted to roughly 1000 mm between June and September.

Pineapple

Soil: Sandy loam soils with a pH of 5.0–6.0 are suitable for plant growth.

Climate: Pineapple is primarily grown at low elevations at temperatures ranging from 15 to 30ºC. The pineapple is drought-resistant due to its particular water storage cells.

Pomegranate

Soil: Cultivation requires well-drained, sandy loam to deep loamy or alluvial soils.

Climate: Pomegranate grows well in semi-arid situations and may be cultivated up to 500 metres above sea level. As long as irrigation is available, it thrives in hot, dry summers and freezing winters. For fruit development and ripening, the tree demands a hot and dry climate.

Sapota

Soil: Sapota grows best in alluvial, sandy loam, red laterite, and medium black soils with good drainage. At higher elevations in places like Punjab and Haryana, it only produces one harvest from summer flowering in April and May.

Climate: It grows well up to an elevation of 1,000 metres, although the seaside climate is perfect for sapota growth. A temperature range of 10–38ºC and annual rainfall of 1250–2500 mm is ideal for sapota production, where it flowers and fruits throughout the year. Temperatures above 43°C cause floral decline.

Litchi

Soil: Deep, well-drained loamy soil rich in organic matter with a pH of 5.0–7.0 is optimal for the crop.

Climate: Litchi is a fruit that grows in humid subtropical climates. It grows best at low elevations and can reach an altitude of 800 metres (msl). Although some temperature

change is required for optimal fruiting, young trees need to be protected from frost and hot winds for several years until they are well-rooted. Summer temperatures should not exceed 40.5ºC, while winter temperatures should not go below freezing. Persistent rain can be dangerous, especially during flowering when it interferes with pollination.

Ber

Soil: The crop requires deep, well-drained loamy soil rich in organic matter with a pH of 5.0–7.0.

Climate: Ber grows in a variety of climates and at elevations of up to 1,000 metres above sea level. It can survive intense heat but is vulnerable to frost and cannot be grown in areas with high atmospheric humidity. Ber thrives in a broad range of soil types, including sandy, clayey, saline, and alkaline soils.

Strawberry

Soil: Strawberries can be cultivated in any soil type, but the optimum is sandy loam soil and very light soil with a pH of 5.7–6.5. The formation of runners necessitates frequent irrigation. Strawberries should not be planted constantly in the same area or on land that has previously been used for potatoes, tomatoes, pepper, and other crops.

Climate: It can be grown all year in tropical and subtropical climates with optimum day temperatures of 22–25ºC and night temperatures of 7–13ºC. Frost and winter injuries have a significant impact on strawberry productivity in cold climates.

Loquat

Soil: Loquat thrives in fertile clay loam soils. It may be cultivated in both loam and sandy loam soils. Plants are harmed by water-logged circumstances.

Climate: Loquat has thrived in North India's harsh climate. It works well in tropical climates and lower hills where the temperature rarely drops below 0ºC. It cannot withstand strong frost in the winter. It is drought- and heat-tolerant. It prefers a warm, dry climate during fruit ripening.

Apple

Soil: Apples thrive in well-drained loams oil with a depth of 45 cm and a pH range of 5.5–6.5. The soil should be free of hard substrata and waterlogging. Heavy clay or tight subsoil should be avoided.

Climate: Apple is a temperate fruit crop. Although apple-growing regions in India do not fall inside the temperate zone, the region's temperate environment is attributable to the Himalayan hills and high elevations. During the active growing stage, the average summer temperature should be between 21 and 24ºC. About 1000 chilling hours are required for complete dormancy in apple. It thrives best in areas where the trees have continuous winter rest and plenty of sunlight for color development. It may be grown at elevations ranging from 1500 to 2700 metres above sea level. A well-distributed rainfall of 1000–1250 mm during the growing season is ideal for apple tree growth and fruitfulness.

Pear

Soil: Red laterite soil with excellent drainage and a high organic matter concentration is perfect for commercial use. This can also be grown at elevations above 1200 metres, with soil pH ranging from 5.8–6.2.

Climate: Pear is adaptable to a wide range of climatic conditions, from –26ºC (in dormancy) to 45ºC (during the growing season). Nevertheless, most of the pear cultivars require about 1200 hours below 7ºC during the winter to complete their chilling requirement to flower and fruit at a good level. However, after bud break, during the blossoming and fruiting stages, temperatures below freezing will severely harm the crop. It is grown in both temperate and subtropical climates due to its tolerance for a wide range of climate and soil conditions. Pears can be grown at elevations ranging from 1300 to 2100 metres above sea level in the tropical belt.

Peach

Soil: Peaches do nicely in light, sandy soils. Deep fertile loam or sandy loam with good drainage is ideal. The pH ranges 5.8–6.8. It cannot withstand poor drainage. Fertile and thick soils provide a risk.

Climate: Peaches prefer mild climates. Peach cultivars with low chilling requirements (250–300 hours) enjoy cold temperatures in winter and hot temperatures (40ºC) in summer for optimal color development and ripening. Peaches are not picky about these requirements.

Plum

Soil: Although plums can grow in a variety of soil types, deep, fertile, well-drained loamy soils with a pH of 5.5–6.5 are the best. Hard pans, waterlogging, and excessive salts should be avoided in the soil. Soils that are too heavy or too light are not suitable. Japanese plums thrive in medium soils with a high pH.

Climate: Plums typically require a mild or temperate climate for growth, but cultivation can be found anywhere from the hills of Kashmir with temperatures touching 0 degrees to the plains of Rajasthan with temperatures exceeding 45ºC. Plums require fewer chilling hours when temperatures are below 7.2ºC.

Apricot

Soil: Apricots are quite hardy and can be grown in almost any soil. The best soil is deep, well-drained soil. The dirt should be 3 metres deep. The soils in Kinnaur, Himachal Pradesh, where apricots are grown in enormous wild stands, are sandy and well-drained but not particularly productive. If the drainage is adequate, the high lime content of the soil does not inhibit tree growth.

Climate: Every year, apricot trees require 600–900 cooling hours at temperatures ranging from 0 to 8ºC. Temperatures below 0°C are hazardous to these plants. The ideal summer temperature is 37ºC. Temperatures exceeding 37ºC will also impede their production.

Almond

Soil: The soil should be well-drained, deep, and loamy. Almonds may survive different types of soil, such as poor soils, as long as they are not moist or poorly draining, which

they cannot endure. Soils that are heavy or poorly drained should be avoided. For cultivation, the pH of the soil should be between 5.5 and 8.5.

Climate: For plant growth and kernel fullness, almonds demand an environment with slightly warmer summer temperatures ranging from 30 to 35ºC and cool winters. Unopened blossoms can withstand temperatures as low as 2.2ºC, but blossoms in the petal-fall stage are damaged at temperatures ranging from 0.5 to –1.1ºC. The flowers can with stand temperatures ranging from 2.2 to –3.3ºC for a short period. Almond showed a requirement of 400–600 chilling hours below 7.2ºC.

Walnut

Soil: Walnuts thrive in well-drained, deep silty loam or clay loam soils that are humus-rich and lime-supplemented. A soil pH of 6.0–7.5 would produce an excellent yield.

Climate: Walnuts are sensitive to both low and high temperatures. The climate should be free of frost in the spring and severe heat in the summer. Even temperatures 2–3ºC below freezing in bloom resulted in the death of a major percentage of immature walnut blooms. If the weather is excessively hot and the humidity is low, nuts turn "blank." They thrive in locations with 75 cm or more rain per year is evenly distributed. Temperatures between 29 and 32ºC near harvest time result in well-filled kernels. Walnuts grow abnormally shriveled in the chilly summer months.

Pecan nut

Soil: Pecan trees can be cultivated in a variety of soil conditions, including sandy loam, clay loam, and alluvial soil from rivers and small streams, although they all have key traits. To a great depth, the soil should be deep, loose, well-drained, and aerated. Pecans may grow in a variety of soil pH conditions. The optimum range is around 6.5; however, in most circumstances, a soil pH between 6.0 and 7.0 would suffice.

Climate: A pecan tree can be grown successfully in places free of severe frost in the spring and excessive heat in the summer. It requires a mean temperature of more than 26.7ºC. It requires a moderate rainfall of 75–100 cm, and it cannot be grown in locations with high rainfall.

Plantation Crops

Plantation crops are perennials that are grown at a large scale by an individual or company. For example, rubber, coconut, coffee, tea, etc. They are also known as cash crops.

Coconut

Soil: Laterite, alluvial, red sandy loam, coastal sandy, and reclaimed soils with pH ranging from 5.2 to 8.0 are the principal soil types that support coconut in India. Coconut farming requires soil with a minimum depth of 1.2 metres and a sufficient amount of water-holding capacity.

Climate: The average yearly temperature for optimum development and yield is said to be 27ºC, with a diurnal fluctuation of 60–70ºC and a relative humidity of more than 60%.

Tea

Soil: Tea requires well-drained soil with a high organic matter content and a pH of 4.5–5.5. The nursery soil should be a well-drained, deep loam with a pH of 4.5–4.8.

Climate: For better growth and development of tea, temperature must be 13–32°C. Annual precipitation must be around 1500 mm especially between April and October.

Coffee

Soil: Coffee can be cultivated in a variety of soil types, but the best is fertile volcanic red earth or deep, sandy loam. Yellow-brown, silty soils are less desirable. Avoid heavy clay or soils with poor drainage. Coffee grows best in soil with a pH of 5–6.

Climate: Coffee is a tropical plant that grows in semi-tropical climates. To grow and yield well, this plant demands heat, humidity, and enough rain. Coffee requires a temperature range of 15–28ºC.

Arecanut

Soil: The most cropped land is found on gravelly laterite soils of the red clay type. It can also thrive in rich clay-loam soils. Arecanut cultivation is not ideal for sticky clay, sandy, alluvial, brackish, or calcareous soils.

Climate: It grows well within the temperature range of 14 and 36ºC but is severely affected by temperatures below 10 and above 40ºC.

Rubber

Soil: Rubber is grown in literate or loamy soil, primarily on slopes and undulating land, or on slightly elevated level land, with no potential for water stagnation. It grows well in a pH range of 4.5–6.0.

Climate: Rubber trees demand damp, humid regions with more than 200 cm of rainfall per year. It thrives in equatorial climates with temperatures exceeding 25ºC.

Cashew

Soil: The best soils for cashews are deep and well-drained sandy loams without a hard pan. Cashew also thrives on pure sandy soils, although mineral deficiencies are more likely to occur. Hard clay soils with poor drainage, as well as soils with a pH higher than 8.0, are not ideal for cashew farming.

Climate: Cashew is only found at altitudes of up to 700 metres above mean sea level where the temperature does not fall below 20ºC for an extended length of time. Cashew grows best in climates with temperatures ranging from 20 to 30ºC and yearly precipitation ranging from 1000 to 2000 mm.

In conclusion, while major fruit crops like citrus, apples, and stone fruits have specific soil and climatic requirements, minor fruit crops **(Fig. 3.2)** such as ber, guava, and pomegranate also play a crucial role in diverse horticultural systems. These minor crops often thrive in more challenging conditions, such as saline or alkaline soils, and contribute significantly to the agricultural landscape.

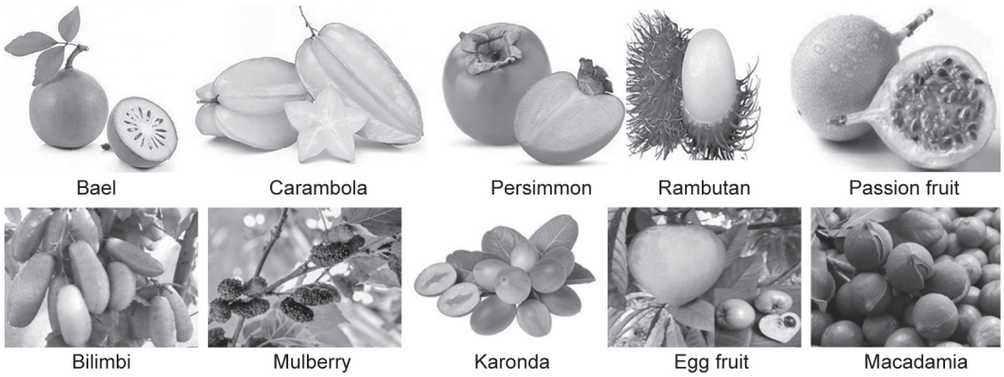

Fig. 3.2: Minor fruit crops *(For colour version see Plate 1)*

Vegetable Crops

Potato

Soil: Rich in organic matter, with good drainage and aeration, is best suited for potato crop cultivation. A pH range of 5.2–6.4 is considered optimal for soil.

Climate: The vegetative growth of the plant is optimum at 24°C, whereas tuber development is best at 20°C.

Tomato

Soil: Tomatoes can be grown in a variety of soil types, from sandy to heavy clay. Well-drained sandy or red loam soils rich in organic matter with a pH range of 6.0–7.0 are preferred. Soil deficient in boron and calcium leads to fruit cracking.

Climate: Tomato is a warm season crop. Temperatures ranging from 21 to 24°C produce the finest fruit colour and quality. Temperatures above 32°C are detrimental to fruit-set and growth. Frost and heavy humidity are too much for the plants.

Chilli

Soil: Chilies can be grown in any soil type; however, sandy loam, clay loam, and loamy soils with pH levels ranging from 5.5 to 7 are ideal. The soil should be thoroughly drained and aerated. Acidic soils make it impossible to grow chilies.

Climate: It thrives in warm, humid climates with temperatures ranging from 20 to 25°C. It is grown in a rain-fed crop in locations with an annual rainfall of 25–30 inches.

Cabbage

Soil: Cabbage is grown mostly on sandy to heavy soils rich in organic materials. Early crops need light soil, whereas late crops flourish on heavy soils due to moisture retention. pH ranges from 6 to 7 is ideal.

Climate: Cabbage is grown extensively in India because the climate is cool and wet. Temperatures between 15 and 21°C are thought to be ideal for crop growth and head formation.

Cauliflower

Soil: Cauliflower should be grown in good, well-drained soil with a pH of 6–7. This optimal garden soil is required for a successful cauliflower yield. Soil deficient in molybdenum causes whip-tail disease in crops.

Climate: The ideal temperature for initial plant growth is around 23ºC, although in later stages, 17–20ºC is preferable. Even at 35ºC, tropical cultivars demonstrate growth. Young seedlings in temperate places may stop growing when temperatures reach around 0ºC, although early cultivars cultivated in the plains of north India and other tropical areas can flourish at temperatures as hig has 35ºC. Lower temperatures of 5ºC to 28–30ºC are required for the transition from the vegetative to the curding phase. Temperatures that are greater or lower than the optimum necessary for cultivar curd development may result in physiological disorders such as redness, leafy curd, and blindness. A temperature rise, a cold period, changes in day length, or other plant stresses are factors that most often cause plants to bolt. When stress goes on long enough, plants switch their energy to the survival of the species and therefore form flowers for reproduction, thus bolting.

Brinjal

Soil: With light soils, an early crop yields well. The crop is fairly acid-tolerant, with a pH range of 6.0–6.8 regarded as optimal for improved growth and development.

Climate: Brinjal is a warm-weather crop that requires a long growing season. It is quite frost-tolerant. A daily average temperature of 13–20ºC is ideal for optimum production. As the temperature dips below 17ºC crop growth suffers greatly.

Knolkhol

Soil: Early maturing cultivars thrive in light soils, while late maturing cultivars thrive in heavy soils. Well-drained soils, on the other hand, produce more. The ideal soil pH for knol-khol cultivation is 5.0–6.8.

Climate: Knol-khol (Kholrabi) seeds sprout successfully at temperatures ranging from 15ºC to 32ºC. This crop thrives at temperatures ranging from 15ºC to 20ºC every month, with maximum and minimum averages of 24ºC and 4.5ºC, respectively.

Pumpkin

Soil: A sandy loam soil rich in organic matter and with good drainage is appropriate. A pH of 6.5 to 7.5 is considered optimal.

Climate: At the beginning of its growth, pumpkin requires a minimum temperature of 18ºC. For cultivation, the ideal temperature range is 25–28ºC.

Capsicum

Soil: Capsicum grows well in well-drained sandy loam soils with good percolation. Growing capsicums need a soil pH of 6–7 and an EC of 1 mm hose/cm.

Climate: Capsicum thrives in moderately low temperatures and during the dry season. Seed germinates best at temperatures ranging from 20–25ºC and grows best at temperatures ranging from 18 to 25ºC. Average daily temperatures of 20–25ºC are ideal for fruit setting.

Okra

Soil: Okra grows best on soils that are neutral to slightly alkaline in pH (6.5–7.5).

Climate: It is a tropical and subtropical climate crop that requires a long, warm, and humid growth season. It is frost-sensitive and cannot flourish in freezing temperatures. Below 20ºC, seeds do not germinate. The ideal temperature between 25 and 30ºC is optimal for germination, growth, and fruit setting.

Floricultural Crops

Rose

Soil: Roses thrive on rich, fertile, well-drained soil that retains moisture. 1 part farmyard manure and 1 part bio-compost should also be included in a soil combination. Roses require apH of around 6.5, which is slightly acidic.

Climate: The ideal climate for rose cultivation should have temperatures ranging from 15ºC to 28ºC. Light plays a crucial role in determining growth. Day length (>12 hours) and heavy overcast, cloudy, or misty conditions inhibit growth.

Gladiolus

Soil: Gladiolus can be grown in a variety of soil types, from sandy to clay loam. It can be grown in deep (at least 30 cm), well-drained, friable soils rich in organic matter and nutrients. The pH should be somewhat acidic, between 5.5 and 6.5. It requires a temperature between 10 and 25ºC during the day and 16ºC during the night for proper growth.

Climate: A warm temperature is excellent for gladiolus cultivation, but extreme heat and cold are detrimental. Gladiolus enjoys bright sunlight and should never be planted in the shade. It requires at least 80% of total sunlight for good growth and flowering.

Carnation

Soil: Carnation grows best in sandy loam soils rich in organic matter and with a pH of 6.0–7.0. Organic matter or compost can be used to improve clay and silt soils.

Climate: Carnation prefers a nighttime temperature of 10–12ºC in the winter and 13–16ºC in the summer. The daytime temperature ranges from 18 to 25ºC. Carnations require plenty of light to grow and flower. Carnation is a plant with a very long day.

Marigold

Soil: Nevertheless, sandy loam soil with a pH of 7.0–7.5 and sufficient aeration and drainage is regarded as optimal for marigold production to a decline in blossom size and quantity. Frost damages plants and flowers during a harsh winter.

Climate: Marigolds demand a moderate climate for lush growth and abundant blooms. Temperatures between 18 and 30°C are ideal for seed germination. Planting is done during the rainy season, winter, and summer; therefore, marigold blooms can be found virtually all the year.

Chrysanthemum

Soil: A well-drained sandy loam with good texture and aeration is perfect for growing chrysanthemums. With a pH of 6.5–7.0 and a high organic content, the soil should be neutral or slightly acidic. Because of their low moisture retention, very light, sandy soils are not suggested.

Climate: Chrysanthemum needs tropical or subtropical climatic conditions for optimum growth and development. An ideal temperature for growing chrysanthemums is 20–28ºC during the day and 15–20ºC at night.

Orchid

Soil: Depending on the species, orchids can thrive on peat moss, fir bark, dried fern roots, sphagnum moss, rock wool, perlite, cork nuggets, stones, coconut fiber, lava rock, or a combination of these materials. Soil pH must be between 5.5 and 6.0 for most orchids. Citric acid is used to reduce pH. Use lime or oyster shells to raise the pH. Micronutrient insufficiency can arise if the pH of the orchid mix is too high.

Climate: Orchid blossoms require a temperature of 20–32ºC and a humidity of 80%.

Lotus

Soil: While American lotus prefers acidic soil (pH 4.5), the Asian variety is said to tolerate substrate levels ranging from 5.5 to 9.0.

Climate: Lotus germinates at temperatures over 13ºC. The majority of cultivars are not cold-hardy. The average daytime temperature required during the growing season (April to September) in the northern hemisphere is 23–27ºC. The sacred lotus goes dormant in winter in areas with low light levels.

Jasmine

Soil: Their cultivation requires well-drained, rich loamy soil with a pH of 6.5–7.5. Jasmine prefers warm, tropical weather. In India, jasmine is produced commercially in open fields.

Climate: Mild winters, warm summers, light rainfall, and bright days are good conditions for successful jasmine growth. Common jasmine is native to environments where the temperature typically ranges from 10 to 35ºC.

Daisy

Soil: Daisy plants prefer rich, fast-draining soil, plenty of water, and plenty of sunlight. They are, nevertheless, quite flexible and will survive poor soil conditions as well as partial shade. In order to produce numerous flowers, incorporate some well-aged animal dung or organic compost into the soil. Daisy plants flourish in soil that is neutral to slightly acidic, with a pH range of 6.0–8.0.

Climate: Daisy seeds grow best at temperatures ranging from 15–23ºC. Gerbera daisies thrive best in temperatures ranging from 21.11–23.88ºC.

Tulip

Soil: A soil pH of 6.0–7.0 is ideal for tulip cultivation. Avoid heavy clay soils and poor soils.

Climate: Tulips can be grown in full or partial sunlight. Tulips cultivated in hills, on the other hand, demand a day temperature of 20–26ºC and a night temperature of 5–12ºC throughout the growing period.

Magnolia

Soil: Magnolias loves moist, well-drained soil that is rich in organic matter, so add some well-rotted manure or compost to the planting hole and thoroughly mix it in. Most magnolias are neutral or slightly acidic soil with a pH of 5.5–6.5.

Climate: It requires temperatures of 18–23ºC during the day and not lower than 12–15ºC at night.