UNIT 4

Horticulture

IMPORTANCE OF FRUITS AND VEGETABLES IN HUMAN DIET

Fruits and vegetables are an essential part of a balanced and healthy diet for human beings. Here are some important details about their importance:

1. Nutritional value: Fruits and vegetables are a rich source of vitamins, minerals, and dietary fiber. They are low in fat and calories, making them an excellent food choice for maintaining a healthy weight.
2. Disease prevention: Eating a diet rich in fruits and vegetables can help reduce the risk of chronic diseases such as heart disease, stroke, and certain types of cancer. This is because they contain various antioxidants and other nutrients that help protect the body from damage caused by free radicals.
3. Digestive health: The fiber content in fruits and vegetables helps promote healthy digestion and prevents constipation. They also contain enzymes that aid in digestion and absorption of nutrients.
4. Hydration: Many fruits and vegetables have a high water content, which helps to keep the body hydrated and maintain healthy skin.
5. Versatility: Fruits and vegetables can be eaten raw, cooked, or used in a variety of recipes. This makes them a versatile and delicious addition to any meal or snack.

Consuming a diet rich in fruits and vegetables is essential for maintaining optimal health and preventing chronic diseases.

CROP DIVERSIFICATION & PROCESSING INDUSTRY

Crop diversification is a process of shifting the cropping pattern from mono-cropping to multiple cropping. It is essential for sustaining agriculture and the environment, improving food security and income generation, and reducing risks associated with single-crop cultivation. Here are some important details about crop diversification:

- Benefits of crop diversification: Crop diversification has several benefits such as reducing soil degradation and erosion, improving soil health and fertility, reducing pest and disease incidence, increasing biodiversity, providing alternative sources of income, and ensuring food security.
- Types of crop diversification: There are two types of crop diversification - intercropping and mixed cropping. Intercropping involves growing two or more crops simultaneously on the same land, while mixed cropping involves growing two or more crops in the same field at different times.
- Processing industry: Crop processing industry refers to the conversion of raw agricultural products into processed products that are more valuable and have a longer shelf life. The processed products include fruits and vegetables, grains, oilseeds, dairy, meat, and poultry products. The processing industry provides employment opportunities, enhances the value of agricultural produce, and helps in reducing post-harvest losses.
- Importance of processing industry: The processing industry is important for reducing the post-harvest losses, enhancing the shelf life of the products, reducing transportation costs, and ensuring availability of food products throughout the year. It also provides employment opportunities and helps in value addition to the agricultural produce.
- Challenges in crop diversification and processing industry: The challenges in crop diversification include lack of knowledge and skills, inadequate infrastructure, insufficient credit facilities, and market linkages. Similarly, the challenges in the processing industry include high capital investment, lack of proper technology and infrastructure, lack of skilled manpower, and low market demand.

Crop diversification and processing industry are important for sustaining agriculture, enhancing food security, and ensuring economic development. The government should take necessary steps to promote these activities by providing necessary infrastructure, credit facilities, and market linkages to farmers and entrepreneurs.

ORCHARD-LOCATION AND LAYOUT

An orchard is a cultivated area of land where various fruit trees are grown for commercial purposes. Here are some important details about the location and layout of an orchard:

1. Location: The location of the orchard should be selected based on factors such as soil type, climate, rainfall, and availability of water. It is important to choose a location that has good drainage and is free from waterlogging. The orchard should also be protected from strong winds and frost.
2. Layout: The layout of an orchard is an important aspect of its management. It involves the arrangement of trees in a manner that facilitates easy access for planting, pruning, harvesting, and other operations. The following are some important points to consider when designing an orchard layout:
   - Row spacing: The distance between rows should be wide enough to allow for machinery and equipment to move through, but narrow enough to ensure efficient use of land.
   - Tree spacing: The distance between trees should be based on the type of tree, rootstock, and the desired yield. It is important to ensure that trees are not overcrowded, as this can lead to poor growth and yield.
   - Orientation: The orientation of the orchard rows should be based on the prevailing winds and sun exposure. This can help to minimize the risk of damage from wind and frost, and ensure optimal photosynthesis for the trees.
   - Water management: The orchard layout should be designed in a manner that facilitates efficient irrigation and drainage. The irrigation system should be designed to ensure that water reaches the root zone of the trees and is not wasted through run-off or evaporation.
   - Access roads: The orchard layout should also include access roads for machinery and equipment. These roads should be wide enough to allow for easy movement of equipment, and should be designed to minimize soil compaction and erosion.

The location and layout of an orchard play a critical role in its productivity and profitability. Proper planning and design can help to ensure efficient use of resources and optimal growth and yield of fruit trees.

ORNAMENTAL GARDENING AND KITCHEN GARDEN

Ornamental gardening and kitchen gardening are two popular types of gardening that serve different purposes. Here are some important details about each type:

1. Ornamental Gardening: This type of gardening involves growing plants for their aesthetic beauty rather than for consumption. It is often used for landscaping, decoration of public spaces, and beautification of private gardens. Some common plants used for ornamental gardening include flowers, shrubs, and trees. Ornamental gardening requires careful planning, soil preparation, and regular maintenance to ensure the health and vitality of the plants.
2. Kitchen Gardening: This type of gardening involves growing vegetables, fruits, and herbs for personal consumption. It is often done in small spaces such as balconies, terraces, and backyard gardens. Kitchen gardening promotes healthy eating habits and can be a fun and rewarding hobby. Some common plants used for kitchen gardening include tomatoes, peppers, lettuce, basil, and mint. Kitchen gardening requires good soil, adequate sunlight, and regular watering and fertilization to produce healthy and nutritious plants.

Both ornamental gardening and kitchen gardening have their unique benefits and are important aspects of horticulture. Ornamental gardening enhances the aesthetic appeal of public and private spaces, while kitchen gardening promotes healthy eating habits and provides fresh produce for personal consumption.

PLANTING SYSTEM AND PROTECTION FROM FROST AND SUNBURN

Planting system: The planting system refers to the arrangement of plants in an orchard or garden. The two main planting systems are square and hexagonal. In square planting, trees are planted in rows with equal distances between trees in the same row and between rows. In hexagonal planting, the trees are planted in a pattern that forms equilateral triangles.

Training: Training is a technique of directing the growth of plants to achieve a desired shape and structure. Proper training is important for the development of healthy and productive trees. There are several methods of training, including central leader, open center, and modified central leader.

Pruning: Pruning is the removal of unwanted parts of the plant to improve its health, shape, and productivity. Pruning is done to remove diseased or damaged branches, promote new growth, and shape the tree. Pruning should be done in the dormant season for most fruit trees.

Intercropping: Intercropping is a technique of growing two or more crops in the same field at the same time. It is done to maximize the use of available resources, such as sunlight, water, and nutrients, and to minimize the risk of

pests and diseases. For example, legumes can be grown between rows of fruit trees to fix nitrogen in the soil.

Protection from frost and sunburn: Frost and sunburn can damage fruit trees, especially young trees. Frost damage occurs when the temperature drops below freezing, and sunburn occurs when the tree bark is exposed to high-intensity sunlight. Protection measures include covering the trees with blankets or burlap during frosty nights, painting the trunk with white latex paint to reflect sunlight, and providing shade using screens or cloth covers.

TREES, SHRUBS, CLIMBERS, ANNUALS AND PERENNIALS

In agriculture, there are various types of plants that can be classified based on their life cycle, growth habit, and other characteristics. Some of the most common categories include trees, shrubs, climbers, annuals, and perennials.

1. Trees: Trees are perennial plants that have a single main stem or trunk and typically grow to a significant height. They can be either deciduous (shed their leaves seasonally) or evergreen (retain their leaves year-round). Some examples of trees include mango, coconut, neem, teak, and banyan.
2. Shrubs: Shrubs are woody plants that are smaller than trees and have multiple stems. They can be deciduous or evergreen and usually grow up to a maximum height of around 6 meters. Some examples of shrubs include rose, hibiscus, bougainvillea, and jasmine.
3. Climbers: Climbers are plants that require support to grow vertically and can be used to cover walls, fences, and other structures. They can be annual or perennial, and some examples include grapevine, passion fruit, ivy, and morning glory.
4. Annuals: Annuals are plants that complete their life cycle within a year. They grow from seed, produce flowers and fruits, and then die. Some common examples of annuals include tomato, chili, marigold, petunia, and sunflower.
5. Perennials: Perennials are plants that live for more than two years and can produce flowers and fruits repeatedly. They can be either herbaceous (non-woody) or woody, and examples include apple, banana, mango, papaya, and rosemary.

Understanding these different categories of plants is important in agriculture as it can help in selecting the appropriate planting techniques, fertilizers, pest management strategies, and other cultivation practices based on the specific needs of each type of plant.

PROPAGATION

Propagation is the process of producing new plants from a variety of sources. There are several methods of plant propagation including seed, cutting, budding, layering, and grafting. Each method has its advantages and disadvantages and is used for different types of plants.

1. Seed Propagation: This is the most common method of propagation and involves planting seeds in the soil or other growing medium. This method is relatively simple and requires minimal equipment, making it an affordable option for farmers. However, it can take longer to produce mature plants, and there is less control over the characteristics of the resulting plant.
2. Cutting Propagation: This involves taking a cutting from a parent plant and placing it in soil or another growing medium to grow roots and become a new plant. This method is useful for propagating plants that do not produce viable seeds, such as many ornamental plants. It is also useful for maintaining the genetic characteristics of a particular plant.
3. Budding Propagation: Budding is a form of grafting that involves taking a bud from a parent plant and grafting it onto a rootstock of another plant. This method is commonly used in fruit tree production to produce trees with desired characteristics.
4. Layering Propagation: This involves bending a low branch or stem of a plant to the ground and covering it with soil. Over time, roots will grow from the covered portion of the stem, and a new plant will develop. This method is commonly used for shrubs, climbers, and other plants with flexible branches.
5. Grafting Propagation: Grafting involves joining two different plants together so that they grow as a single plant. The scion is the top part of the plant that contains the desired characteristics, and the rootstock is the bottom part that provides the root system. Grafting is commonly used in fruit tree production to produce trees with desired characteristics.

Plant propagation is an important aspect of agriculture, and different methods of propagation are used for different types of plants. It is important for farmers to understand the advantages and disadvantages of each method to choose the appropriate method for the specific plant they are propagating.

CULTIVATION PRACTICES, PROCESSING AND MARKETING

MANGO

Mango (Mangifera indica L.) is a member of the Anacardiaceae family and the Mangifera genus with a basic chromosome number of X = 20. In India, it is considered the choicest fruit and is known as the "king of fruits". It is an excellent source of vitamin A and a good source of vitamin C, as well as various minerals and vitamins.

Soil and Climatic Requirements: Mango can be grown in a variety of soils but clay-loam, well-drained soils with a pH range of 5.7 to 7.5 are considered to be the best for its cultivation. A temperature range of 24-27°C throughout the growing season is the best for its cultivation.

Commercial Varieties: In India, there are several varieties of mango but only 10-12 are grown commercially. For example, Dashehari, Langra, Chausa and Bombay Green are grown commercially in north, Banganpalli/Baneshan, Neelum, Totapuri in south, Alphonso and Kesar in west and Langra, Himsagar etc. in the east. On the basis of embryos, mango varieties have been classified as monoembryonic (Most of the varieties) and polyembryonic (Bapakai, Vellary, Chandrakaran, Kurrukan, Goa, Olour, Carabao, Paho, Peach, Apricot, Strawberry etc.)

Propagation: Mango can be propagated both by sexual and asexual means but it is mainly propagated by veneer grafting, stone grafting and soft-wood grafting in different parts of India.

Planting Distance and Time: Planting distance varies from variety-to-variety and locality-to-locality. In general, a planting distance of 10-12m is recommended for commercial varieties like Dashehari, Langra, Chausa, Alphonso, Banganpalli etc. Pits of 1 × 1 × 1 m size are dug out and kept open during May, which are refilled by the end of the June with the mixture of top soil and Farm Yard Manure in the ratio of 1 : 1. The best time for planting mango is the monsoon season.

Manures and Fertilizers: In general, ammonium sulphate, super phosphate and sulphate of potash should be mixed in the ratio of 1 : 3 : 1 and applied @ ½ kg in the first year, which should be increased by kg every year up to 15th year, and then 6-10 kg afterwards. Farm yard manure (FYM) is generally applied in September-October every year.

Irrigation: Young plants should be irrigated at weekly intervals in summer and at fortnightly intervals in winter. However, the bearing plants should be irrigated at 10-15 days interval from fruit set stage to maturity. It is, however, advised to withheld irrigation during flowering as it may result in shedding of flowers.

Plant Protection

Insect-pest	Control measures
Mango leaf hopper	Mango hoppers can be controlled by two sprays of carbaryl (0.1%) or diazinon (0.2%) during January-February at fortnightly intervals.
Mango mealy bug	Kill nymphs and females by spraying metasystox (0.2%). Follow banding of tree trunks with 30 cm wide alkathene.
Stone weevil	Difficult to control, however, bagging of fruits, destruction of affected fallen fruits and disposal of debris, etc., can bring out reduction in the insect number.
Fruit fly	Collect and destroy the affected fruits. Use baits (malathion (0.05%) + jaggery + eugenol) at 4-5 places in open containers to attract the adult flies, and control them effectively. Raking of soil in May-June is equally useful as it helps in the killing of pupae.

Diseases

Powdery mildew	Two sprays of karathane (0.1%) at fortnightly interval completely control this disease. One preventive spray of karathane (0.1%) as soon as cloudy weather appears during flowering time.
Anthracnose	Spray zineb (0.2%). However, a preventive spray of Bordeaux mixture (4:4:50) is always useful in humid areas before panicle emergence.

Physiological Disorders

Malformation: It is most dreaded disorder of mango in northern parts of India, the causal agent of which is still unknown. Most of the commercial varieties in subtropical parts of India are affected by malformation and southern parts are virtually free from it. Plants both in nursery and field are affected by this malady. The symptoms of this malady are characterized by the transformation of inflorescence into compact mass with predominating male flowers.

This disorder is commonly related to the prevailing environmental temperature. Panicles emerging during late-December or early- January (when the environmental temperature is comparatively low) are worst affected by malformation.

The following control measures reduce the incidence of malformation:

1. Remove and burn all the affected malformed panicles and branches as and when they emerge. Mango malformation is the most dreaded malady of mango in north India; its causes are not yet known, however, temperature plays a vital role. De-blossoming of malformed panicles during December-January is most useful solution.
2. Follow up de-blossoming in January.
3. Application of methanol leaf extract of Ruelia tuberosa (12 g leaf per litre solution) reduces malformation in cv. Dashehari. However, the concentration is variety specific, which needs to be standardized.
4. Spray NAA (200 ppm) in October.

Spongy tissue: Spongy tissue disorder accounts for more than 30 per cent loss in Alphonso mango. In this disorder, a

non-edible, sour, yellowish and sponge like patch develops in one part of the fruit during ripening. The fruit pulp remains unripe but the fruits look normal in external appearance. On cutting, the fruits emit bad odour and are unfit for human consumption. The precise cause of this malady is still unknown. However, recent studies indicate that fruits low in Ca content are worst affected by spongy tissue disorder and the convecteric heat of the soil adds more to this disorder. Use of sod culture, green vegetation, leguminous crop cover or mulching at pre-harvest stage are some measures to reduce this disorder to some extent.

Maturity and Harvesting

Depending on variety and growing environment, mango fruits take 90-120 days to reach harvest maturity. Various indices have been suggested to determine the harvest maturity of mango, e.g., change of peel colour, natural falling of some fruits from the tree (tapka) formation of abscission layer at pedicel joint, specific gravity of fruits (1.01-1.02), etc. Harvesting is done manually. The most useful tool for this purpose is a long bamboo pole fitted with a cutting shear and a collecting net below it at the distil end of the pole.

PAPAYA

Papaya, also known as Carica papaya, is a tropical fruit tree native to Central America and Mexico but now widely cultivated in many parts of the world. Papayas are grown for their sweet and juicy fruits, which are high in vitamin C, fiber, and other nutrients. In addition to their culinary uses, papaya fruits and other parts of the tree are also used for medicinal purposes. The papaya tree is fast-growing and relatively easy to cultivate, making it an important crop in many tropical and subtropical regions.

Soil and Climatic Requirements: Papaya grows well in a warm and humid climate with a temperature range of 25-30°C. It requires well-drained, deep and fertile soils rich in organic matter, with a pH range of 6-7.

Commercial Varieties: Some popular papaya varieties are Solo Sunrise, Red Lady, Maradol, and Tainung No. 1.

Propagation: Papaya can be propagated through seeds or vegetative means like cuttings, air layering or budding.

Planting Distance and Time: The distance between plants in a papaya orchard depends on the cultivar and the soil fertility. Generally, plants are spaced 2.5-3 meters apart in rows that are 3-4 meters apart. Papaya can be planted throughout the year in tropical climates, but the best time to plant is during the monsoon season.

Manures and Fertilizers: Papaya requires regular application of organic manure such as well-rotted farmyard manure, compost or green manure. For optimal growth and yield, papaya requires balanced fertilization with macro and micro-nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and iron.

Irrigation: Papaya requires frequent and adequate irrigation during the growing season. Inadequate irrigation can result in stunted growth, while over-irrigation can lead to root rot.

Plant Protection: Papaya is susceptible to pests like fruit flies, mealybugs, mites, aphids, and scale insects, as well as diseases like powdery mildew, anthracnose, and damping-off. Proper sanitation practices, use of biocontrol agents, and timely application of pesticides can help manage these problems.

Diseases: Papaya plants are susceptible to several fungal, bacterial, and viral diseases, including anthracnose, powdery mildew, root rot, bacterial wilt, and papaya ring spot virus. Crop rotation, proper sanitation practices, and use of disease-resistant cultivars can help control these diseases.

Physiological Disorders: Papaya can also suffer from physiological disorders like fruit drop, fruit cracking, and fruit splitting, which can be managed by providing proper irrigation, nutrition, and care.

Maturity and Harvesting: Papaya fruits are harvested when they reach physiological maturity and begin to change color from green to yellow or orange. The ideal stage for harvesting papaya is when it has 1/3 of yellow color on the fruit. Papaya fruits continue to ripen even after they are harvested, and they should be stored at room temperature until they reach desired ripeness.

BANANA

Banana, a popular fruit, belongs to the family Musaceae and the genus Musa. It has a basic chromosome number of X=11. The edible varieties of banana have been developed from two species, Musa acuminata and Musa balbisiana, based on their genomic constitution. Bananas are a good source of carbohydrates and minerals such as potassium and sodium. They can be consumed fresh or used to make value-added products like chips and puree. India is the second-largest banana-growing country after Brazil, with Kerala, Maharashtra, and Tamil Nadu being major contributors to its production and acreage.

Soil and Climatic Requirements: Clay to sandy clay-loam soil is the most suitable for banana cultivation. However, the best soil is medium textured soil, having pH between 5.5-8.0. It enjoys an annual rainfall ranging from 100 to 325 cm. Banana is well adapted to areas with temperature between 21-32°C, and annual rainfall between 1,000-2,000 mm.

Commercial Varieties/Clones: The major varieties are Poovan, Basrai, Monthan, Harichal, Rasthali, Hill Banana, Nendran, Sevazhai and Kunnan.

Propagation: Bananas are propagated from offshoots (suckers) or rhizomes.

Planting System: Square, rectangle and triangle system are recommended systems for banana planting. For mono-cultured cropping system, the recommended planting distance is 3.0 × 1.5 m. For high-density planting, distance is reduced significantly.

Thinning of Suckers or Desuckering: Thinning of suckers involves removal of unwanted suckers; normally weak unhealthy, mainly water sucker using sharp knife at the ground level, leaving 1 bearer, one follower and one sucker per clump at any time.

Fertilizer Application: Banana requires high fertilization due to its rapid and vigorous growth and high fruit yield. It removes nearly 250-300 kg N, 25-40 kg P and 800-1200 kg K, 150-180 kg Ca, 40-60 kg Mg and 14-20 kg S per hectare. Usually, 300 Kg N, 40-50 Kg P and 250-300 K should be given per ha.

Water Management: Banana plant should be irrigated to encourage development and healthy growth especially in the early years of growth. Micro-sprinkler or drip irrigation system is recommended. Areas with frequent flash flood, construction of in-field drainage is recommended.

Plant Protection

Insect-pests	Control measures
Corm weevil	Use healthy materials and treat rhizomes with hot water for 5-10 minutes. Ensure good sanitation. Drench with dieldrin.
Stem borer weevil	Ensure good sanitation. Spray with dieldrin.
Nematode	Hot water treatment. Sanitation. Drench with fenamiphos. Wrapping of fruit with polyethylene bags.

Diseases	Control measures
Leaf spot	Used resistant cultivar. Spray with benomyl (0.03%).
Panama disease (Fusarium wilt)	Use resistant variety. Ensure good sanitation. Use disease free planting material.
Bunchy top	Adoption of strict quarantine measures, destroy infected plant material. Control aphid by spraying metasystox or dimecron (0.01%)

Maturity, Harvesting and Yield: Depending on the variety, banana starts to bear fruit in 6-8 months after planting. It is ready for harvesting in about 7-11 weeks later.

GUAVA

Guava (Psidium guajava L.) belongs to the family Myrtaceae and the genus Psidium with a basic chromosome number of 11. It is known as the "apple of tropics" and "poor man's fruit" in India. Guava is a rich source of vitamin C, pectin, and a good source of vitamins, minerals like calcium and phosphorus. Its high pectin content makes it an excellent fruit for making jelly. In India, it is mainly cultivated in Uttar Pradesh, Madhya Pradesh, Bihar, and Maharashtra. The Allahabad region in Uttar Pradesh is known for producing the best quality guavas in the world.

Soil and Climatic Requirements: Guava is a hardy fruit plant and can thrive on all types of soils, ranging from heavy clay to light soils. However, the clay loam, deep, friable and well-drained soils are best. It can be grown in soils having pH up to 9.0, though the optimum range is 4.5 to 7.5. Under highly waterlogged, saline and alkaline conditions, its cultivation is adversely affected.

However, both yield and fruit quality are better in areas with distinct winter.

Commercial Varieties: Important varieties of guava are Allahabad Safeda, Sardar (Lucknow-49), Behat Coconut, Seedless, Apple Colour, Banarasi Surkha, Chittidar, Arka Kiran, Swetha.

Propagation: Guava can be propagated both by seed and a sexual means. Most important methods of vegetative propagation are air layering/gootee, stooling, softwood grafting and budding. Now-a-days, stooling is preferred.

Planting: The pits of 1 × 1 × 1 m size should be dug out at appropriate distance in a square system before monsoon. The pits are refilled with 25-30 kg well decomposed farm yard manure, mixed with top soil and irrigated. The best planting time is onset of monsoon. Guava is usually planted at a distance of 7 to 8 m.

Irrigation: Guava is a hardy fruit plant and requires very less water. However, in the early stages of orchard establishment, plants require frequent irrigation. Later, more frequent irrigation (fortnightly interval) is required from April to June for good growth and fruit yield. Due to regular growth, flowering and fruiting in south India, guava requires irrigation throughout the year.

Manuring and Fertilization: Ten-year-old guava tree should be given about 80 kg of FYM, 1 kg of ammonium sulphate or 800 g of calcium ammonium nitrate, 3 kg of super-phosphate and 2 kg of potassium sulphate. The fertilizers should be applied in two split doses (June and October) when there is sufficient moisture in the soil.

Flowering and Crop Regulation: Guava flowers twice a year in north India. First flowering takes place in April-May, which gives fruits in rainy season. The second flowering takes place in August-September to give fruiting in winter season. The rainy season crop is generally avoided as most of the fruits are infested by fruitfly and the fruits are insipid and of very poor quality. The winter crop is virtually free from fruitfly and the fruits are of high quality. Winter crop is therefore, preferred as it gives very high returns to the

farmers. In central-southern India, guava flowers thrice a year, with flowers appearing in October also. In West Bengal, guava flowers once in April-May and again in September-October.

In areas where guava flowers twice or thrice a year, we need to regulate crop in such a way that only quality crop is harvested. In this process, winter and rainy season crop is avoided. This can be done by forcing the plants to take rest in the undesired season by stopping irrigation, and then applying fertilizers and manures in the desired season. De-blossoming can be done by spraying NAA (100 ppm) or 2,4-D (30 ppm) in summer.

Plant Protection

Insect pests	Damage	Control measures
Fruit fly	Most serious pest of rainy season crop, renders whole crop unfit for consumption. Maggots on hatching, enter the fruits, and feed inside.	Soil raking, destruction of infected fruits, use of baits (sugar + malathion) and spraying plants with malathion (0.05%) or dimecron (0.03%) during oviposition period are some useful measures.
Mealy bug	Causes damage by sucking cell sap from tender leaves, shoots, flowers and fruits. The affected leaves dry up and the fruits drop off, resulting in poor yield.	The banding of the tree trunk with polyethylene film or Ostico-sticky bands is the best method to prevent them climbing up the tree. Further, treatment of soil with aldrin or malathion is also effective.

Diseases	Symptoms	Control measures
Wilt	This disease is characterized by yellowing of leaves, followed by drying of the leaves. The twigs start drying from tip downwards. The plant may collapse slowly in several or within 15-20 days.	Remove and burn the infected plants, maintain proper drainage, grow wilt resistant varieties (L-49, Banarasi), avoid planting in highly alkaline soils, disinfect soil with 2 per cent formaldehyde solution before planting, and drench soil with brassicol or spray bavistin (0.1%) at an interval of 15 days at early stages of disease infection.
Anthracnose	Die-back starts from top of the branch. Other plant parts, like shoots, leaves and fruits are readily affected. High humidity and frequent rains favour the spread and intensity of disease.	Spray dithane-Z-78 or phytolan (0.2%) at fortnightly interval.

Maturity and Harvesting: Seedling guava plants have 5-6 years juvenile phase whereas the grafted or layered plants start bearing after 2-3 years. Change in fruit colour is usually taken as harvesting index. As soon as colour starts turning from greenish-to-yellowish, the fruits should be harvested. Hand picking of fruits at regular intervals is preferred. Harvesting by shaking of tree may cause severe damage to fruits and the tree. Guava starts giving economic yields after 8-10 years of planting. In general, grafted plant of 8-10 years age can yield 400 to 800 fruits weighing 80 to 100 kg. Guavas are highly perishable and must be marketed immediately after harvest.

CITRUS

Citrus fruits are a group of fruits that includes mandarin (Citrus reticulata) , sweet orange (Citrus sinensis) , lemon (Citrus limon) , lime (Citrus aurantifolia) , pummelo (Citrus grandis) , and grapefruit (C. paradisi) , all of which belong to the family Rutaceae and have a basic chromosome number of X = 8. The edible portion of these fruits is the juice present in the vesicles, which contains 12-14% sugars, citric acid, and ascorbic acid (Vitamin C). India has several major citrus producing states, including Maharashtra, Andhra Pradesh, Punjab, the northeastern states, Karnataka, and Bihar.

Soil and Climatic Requirements: Commercial citrus cultivation in India is done on soils ranging from coarse sands to heavy clays, Ideal pH ranges from 5.5 to 6.0. The growth and development in citrus is optimum in temperature regimes ranging from 25 to 30°C to minimum of 13°C. Annual rainfall of 800-900 mm, well distributed throughout the year is optimum for citrus growth and production.

Commercial Cultivars

Sweet oranges	Mosambi, Sathgudi, Valencia, Pineapple, Jaffa, Hamlin, Shamouti, Malta, Malta Blood Red, Ruby etc.
Mandarins	Owara, Silver Hill, King, Willow Leaf, Nagpuri, Khasi, Coorg, Kinnow and Satsuma.
Lemon	Eureka, Lisbon, Assam lemon, Pani Jamir, Meyer lemon, Karna Khatta, and *galgal* (hill lemon).
Lime	West Indian lime, Kagzi, Tahiti lime (Persian), Pond, etc.
Grapefruit	Duncan, Foster, Marsh Seedless Thompson Seedless, Red Blush.
Pummelo	Nagpur (chakotra), Common pummelo.

Propagation and Rootstock: Citrus trees are propagated by both vegetative mean and sexually by seeds. Vegetative methods are preferred because they ensure uniformity in quality and bearing. Seeds of several citrus species are polyembryonic and nuclear seedlings, which produce true-to-type plants. Mandarins and acid limes are mostly propagated as seedlings. Lemons, citrons, sweet limes are easily propagated by stem cuttings. Air-layering is mostly practiced in pummelo, mandarin, acid lime and seedless lemons. Most of citrus cultivars are propagated by 'T' budding on a suitable rootstock.

Rootstock and Polyembryony: Rootstocks commonly employed for citrus propagation are rough lemon, sour orange (C. aurantium L.) , Karna Khatta (C. karna) , Rangpur lime (C. reticulata) , sweet orange (C. sinensis L. Osbeck), Citranges like Troyer, trifoliate orange (Poncirus trifoliata L. Raf.), and Cleopatra mandarin.

Planting: Commonly planted in a square or rectangular system. In square system, the planting density of 4 × 4 m, 5 × 5 m, 3 × 3 m can accommodate 625, 400, 1111 plants/ha, respectively. Pits of size 50 × 50 cm are dug in summer according to the layout plan and mixed with 15-20 kg well rotten FYM and 50 g chloropyrophos (to kill white ants) and filled tightly with top soil. The best planting time is beginning of rainy season.

Nutrient Management: For sustainable production of fruits and for proper maintenance of plant and soil health, efficient nutrient management programme must be adopted. Citrus is a nutrient exhaustive crop as plants in the population density of 400 plants/ha can remove about 200 kg N, 50 kg P_2O_5 and 200 kg K_2O /ha. Foliar spray of micronutrients has given beneficial effect on improving the yield and quality. One to 2% urea, alongwith $ZnSO_4$, $MnSO_4$, $MgSO_4$ (each 0.5%) and $CuSO_4$ (0.25%) is beneficial for all citrus cultivars.

Physiological Disorders

Granulation: This is the major disorder of sweet orange, mandarin wherein the juice sacs become tough, enlarged, colourless and tastelss. There is a marked increase in the pectic substances, gels etc. and marked decline in sugars, organic acids and carotenoids. These fruits are insipid and fetch poor price in the market. Some of the factors associated with it are: high soil humidity, high relative humidity and temperature during fruit growth. Hamlin and Mosambi orange are highly prone to granulation. This malady can be kept under control with the application of 16 ppm of 2,4-D on developing fruits.

Similar, effect was also noted with the spray of $ZnSO_4$ + $CuSO_4$ + KCl each at 0.25% at monthly interval from August to October.

Fruit cracking: This is a common disorder of sweet orange and acid lime. The splitting starts at stylar end and progresses towards the pedicelar end. Splitting is basically caused due to factors like deficit soil moisture, atmospheric temperature and relative humidity. Borax (0.2%) spray can check splitting and timely application of irrigation water must be ensured.

Plant Protection

Insect-pest	Damage	Control measures
Aphids (Several species)	Aphids suck sap from young leaves and twigs thereby causing severe curling of leaves, stunting of plant and facilitate sooty mould growth by excreting honeydew. These aphids act as vector for Tristeza virus.	Sprays of monocrotophos (0.025%), phosphomidon (0.03%) or parathion (0.03%) are useful for the control of aphids.
Citrus psylla	Suck sap from young leaves and act as a vector for transmitting greening disease	Spray systemic insecticides like phosphomidon (0.03%), monocrotophos (0 025%) or oxydemeton methyl (0.03%).
Leaf minor	Young ones cause damage by mining the leaves	Synthetic pyrethroids viz., fenvalerate (0.01%), permethrin (0.005%) or cypetnethrin (0.001%) are most effective.
Lemon butterfly	Caterpillars defoliate entire leaves.	Dusting and spraying with sevin (0.1%) has been found very effective.
Fruit sucking moth	Adult insects suck sap from mature fruits, thereby leading to fruit rot and drop.	Use light traps

Diseases	Symptoms	Control measures
Tristeza	Symptoms like stem pitting, seedling yellows, etc. infected plants show poor growth, die back, defoliations and ultimately death.	Use tolerant rootstock like Rangpur lime, Cleopatra mandarin, Trifoliate orange, use certified bud-wood, control aphids by insecticides.

Greening	The symptoms appear as chlorosis resembling Zn deficiency, short twigs with upright yellow leaves, leaf drop, dieback, formation of multiple buds and disfigured fruits.	Tree injection with tetracycline or employing cross protection is found to be effective. Control citrus psylla by suitable insecticides.
Phytophthora rot or gummosis	Symptoms are noted as root rot, gummosis, blight of seedlings and fruit rot.	Use resistant rootstocks like *Poncirus trifoliata* or sour orange. Soil drenching with foltaf (0.2%) or avoiding water stagnation around tree trunk is widely adopted practices.
Bacterial canker	Acid limes are most susceptible. Development of lesions with halo on leaves, twigs and fruits.	Spray 1% Bordeaux mixture or 500 ppm streptomycin sulphate and control of leaf miner (insect vector) by metasystox (0.1%). Prune infected portions.

Maturity, Harvesting and Yield

Time of harvest in citrus varies with the region (tropical and subtropical) and the species. Marketable maturity is generally judged with the change in rind colour. Commercially, TSS: acid ratio is the most reliable method and it ranges from 10:1 to 16:1, depending upon citrus species and flush. 'Khasi mandarin' in Northern-Eastern states is harvested during October-January, while 'Darjeeling' mandarin is harvested during November-December. Kinnow in Punjab is harvested during January-February; Citrus canker during April-July. Mosambi is harvested in April-June (1st crop) in Maharashtra. Hand picking is the most popular method to collect fruits while in some regions, harvesting by shaking of main trunk is also done. Maximum productivity in citrus ranges from 700 to 1,000 fruits per tree which depends on the age of plant, cultivar, rootstock and management practices. Kinnow plant can yield 300 to 800 fruits/ plant, mandarin give 500 fruits per plant.

GRAPES

Grape (Vitis vinifera L.) is a highly desirable, refreshing, and nutritious fruit belonging to the family Vitiaceae. Grapes are versatile and can be utilized in many ways. The majority of the grape harvest, around 80 percent, is used for wine production, while the remaining 20 percent is utilized for raisins, juice, and canning. France, Italy, and Spain are the leading producers of wine, while in India, grapes are mainly consumed as fresh fruit.

Soil and Climatic Requirements: Well drained sandy-loam soil and fairly fertile soil, having good amount of organic matter is best for cultivation of grapes. Heavy clay, sand or slit are unsuitable for grape. Grape is relatively tolerant to soil salinity and alkalinity.

Grape requires a long, dry and moderately hot season during cane maturity and ripening of berries followed by cool winter. Rains during growing season are useful, but continuous rains, make it difficult to control diseases. Rains at the time of berry ripening are harmful as even a single shower of rain during berry ripening can destroy the whole crop. Bright sunny days help in accumulation of sugar in berries.

Commercial Cultivars

Table grapes	Thompson Seedless, Pusa Seedless, Perlette, Beauty Seedless, Pusa Urvashi, Bhokri, Cardinal and Black Muskat.
Raisin grapes	Black Corinth, Thompson Seedless, Muscat of Alexandria, Sundekhani, Pusa Seedless and Kismish Beli.
Juice grapes	Early Muscat, Black Champa, Concord, Bangalore Blue, White Riesling, Arka Hans, and Pusa Navrang.
Wine grapes	White Riesling, Pinot Noir, Cabernet Sauvignon, Black Cheaper, Rubired, Madeleine Angevine, Cheema Sahebi and Pusa Navrang.
Canning grapes	Thompson Seedless, Pusa Seedless and Perlette.
Grape varieties can be seeded or seedless, as grouped hereunder:	
(a) Seeded cultivars	Anab-e-Shahi, Bangalore Blue, Bhokri (Panchdraksha), Cardinal, Cheema Sahebi, Gold, Gulabi, Pearl of Casaba, Pinot Noir, Arka Kanchan, Arka Shyam, Arka Hans, Pusa Navrang etc.
(b) Seedless cultivars	Beauty Seedless, Pusa Seedless, Perlette, Thompson Seedless, Delight, Himrod, Kishmish Charni, Arkavati, Pusa Urvashi etc.
(c) Selections	Some selections have been made by farmers. Tas-e-Ganesh, a selection from Thompson Seedless is popular in Maharashtra. Dilkush, Manik Chaman and Sonaka have been selected from Anab-e-Shahi.

Propagation and Rootstock: Grape is commercially propagated through hardwood cuttings. The length of cuttings should be 25-30 cm, having at least 4 buds and of pencil thickness. The best time for preparation of cutting in

north India is at the time of annual pruning in mid-January. Under certain specific conditions to impart protection from soil borne diseases and advance soil conditions (e.g., salinity), commercial varieties are budded or grafted on desired rootstocks (e.g., Dog Ridge, Salt Creek). 'T' and 'Chip' budding are successful methods for grape propagation.

Planting: Normally, a spacing of 2 m × 2 m is recommended for head system, 3 × 3 m for trellis and bower system, for low and medium varieties. The poles should be fixed at a specific distance, depending on the training system. Usually, one-year-old rooted cuttings are planted. The planting is done during January-February in north India and during March- April and September-October in southern India.

Training: Training is done to give proper shape and desired growth for good quantity and quality of fruiting. The different training systems are bower, head, kniffin, trellis, telephone, etc. The most commonly followed training system is bower system, which is also called as Arbour or Pergola system of training. It is best suited for vigorous cultivars like Thompson Seedless, Anab-e-Shahi, Cheema Sahebi and Bhokri.

Pruning: Judicious removal of any plant part for increased productivity, facilitation of various cultural operation, regulation of crop and maintenance of vitality of vine is referred to as pruning. In north India, it is done during dormant season, from late-December to end-January, and in south, pruning for fruiting cycle is done during October-November and the foundation pruning for vegetative growth is done in April. After pruning, a single spray of blitox (0.2 per cent) should be done to avoid fungal attack on the cut portion of the vines. By staggered pruning, Bangalore Blue, Panch Drakshi and Anab-e-Shahi cultivars give two crops in a year.

Irrigation: In north India, the grape is irrigated at 7-10 days interval during growing season until beginning of sugar formation in berries.

Manuring and Fertilization:

(a) Vines under the age of 3-5 years, should be given 40-50 kg well rotten FYM, and fertilizer combination of 500 g N + 300 g P_2O_5 + 700 g K_2O.

(b) Vines above 5 years of age, should be given 50-70 kg well rotten FYM and fertilizer combination of 500 g N + 700 g P_2O_5 + 1000 g K_2O per year.

Crop regulation and quality improvement:

(a) Pruning and thinning: A sizeable number of canes should be retained during pruning. In general, 60-70 clusters are considered optimum on Bower system at 3 × 3 m spacing. Berry thinning helps in proper development of berries, good colour, ripening and quality.

(b) Girdling: It consists of removal of a complete ring (0.5 cm) of bark from the shoot, trunk or cane of a plant. The stage of girdling depends upon the cultivar and the grower's interest. For example, to improve berry set and yield, girdling is done one week before flowering, for increasing berry size, it is done at berry set or just after set and for advancing ripening, uniform colour and quality development, it is done at verasion within a month. This technique is very effective if integrated with pruning, thinning or growth regulators sprays.

(c) Growth regulators: GA3 has been found to be highly beneficial in loosening the bunches, increasing berry size and yield and in improving fruit quality in seedless varieties like Thompson Seedless, Beauty Seedless, Pusa Seedless etc.

Plant Protection

Insect-pest	Damage	Control measures
Chafer beetle	It feeds on buds, young and old leaves, eating away whole lamina, leaving only the skeleton of veins.	Dust chloropyriphos dust on plants.
Thrips	Thrips suck sap from the lower leaf surface, producing silvery blotches, affected parts turn brown, dry and brittle, which later drop off.	Spray malathion (0.5%) during March.

Causal Diseases	Symptoms	Control measures
Powdery mildew	Virulent in south India. Powdery growth of fungus develops on the leaves and berries, which may drop. Berries do not ripen properly, become hard and crack.	Sulphur dusting or spraying wettable sulphur (0.2%) or karathane (0.1%) protect the vine from powdery mildew.
Downy mildew	Initially, light-yellow translucent spots appear on the upper surface of leaf. Afterwards, white mould patches develop on the lower surface of the leaf. Severely affected leaves, flowers and young berries may dry and drop off.	Spraying Bordeaux mixture (1%) at a weekly interval or fytolan (0.25%) holds good for control of downy mildew.

Anthracnose	There is development of erupted brown to black spots on all green parts of the vine. The growth is completely checked, resulting in death of affected parts and splitting of bark.	Destroy affected plant parts. Spray 0.2 per cent copper oxychloride or blitox (0.3%) or fytolan (0.3%) or bavistin (0.2%) at fortnightly interval during rainy season.

Maturity, Harvesting and Yield: Grape is a non-climacteric fruit and does not ripen after harvest. Therefore, fully ripe fruits are harvested. Most commonly used maturity index is colour change, depending upon the cultivar. The bunches after harvesting should be kept in shade. Grading is done considering size, colour and variety. Packing is done in hard cardboard boxes with appropriate cushioning or packing material. Well-maintained vineyard of Perlette, Thompson Seedless may yield about 25-30 and 15-20 t/ha, respectively.

RADISH

Radish is an edible root vegetable belonging to the Brassicaceae family. It is widely cultivated and consumed throughout the world for its crisp texture and peppery flavor. Radishes come in a variety of shapes, sizes, and colors, ranging from small, round, red radishes to long, white daikon radishes. This vegetable is known for its ability to grow quickly, making it a popular choice for home gardeners and commercial farmers alike. In addition to being a tasty addition to salads and sandwiches, radishes are also packed with nutrients and are believed to have several health benefits.

Soil and Climatic Requirements: Radish is a cool-season crop that prefers well-drained, fertile soil with a pH range of 5.5 to 6.8. It grows well in cool weather and requires temperatures ranging from 10 to 25°C for optimal growth. It also requires a good amount of sunlight and prefers a slightly moist soil.

Commercial Varieties: There are many commercial varieties of radish available, including Cherry Belle, Early Scarlet Globe, French Breakfast, White Icicle, and Easter Egg.

Propagation: Radish is propagated by seeds. The seeds can be sown directly into the soil, usually at a depth of 1-2 cm.

Planting Distance and Time: The optimal time for planting radish is in early spring or late summer. The distance between the plants should be around 5-10 cm apart, and the rows should be spaced 20-30 cm apart.

Manures and Fertilizers: Radish requires a good amount of nutrients for optimal growth. Incorporating well-rotted organic manure or compost into the soil before planting can help improve soil fertility. Nitrogen-based fertilizers can also be added during the growth period to provide the necessary nutrients.

Irrigation: Radish requires regular watering, especially during dry spells. Irrigation should be done in the morning or evening to reduce water loss through evaporation.

Plant Protection: Radish plants are prone to attack by pests such as aphids, flea beetles, and cutworms. To prevent pest infestations, the plants can be covered with row covers or sprayed with insecticides. Weeds can also be a problem, and regular hoeing and weeding should be done to keep the area around the plants free of weeds.

Diseases: Radish plants are susceptible to diseases such as clubroot, damping-off, and white rust. To prevent the spread of diseases, infected plants should be removed from the garden and destroyed.

Physiological Disorders: Radish plants can also be affected by physiological disorders such as bolting, which is the premature flowering of the plant. This can be prevented by planting radish during the cooler months and by avoiding excessive nitrogen fertilization.

Maturity and Harvesting: Radish is a fast-growing crop that matures in around 3-4 weeks after planting. The crop is ready for harvesting when the radishes have reached their full size and the roots are firm. The radishes can be pulled out of the soil by hand, and the leaves and stems can be cut off before storage.

CARROT

Carrot (Daucus carota) is a root vegetable that is widely cultivated all over the world. It is a biennial plant that belongs to the Apiaceae family, which also includes other vegetables such as parsley, celery, and fennel. The edible part of the carrot is the taproot, which is typically long, cylindrical, and orange in color, although there are also other varieties with different colors such as white, purple, red, and yellow. Carrots are known for their high nutritional value, particularly their beta-carotene content, which is a precursor to vitamin A. They are commonly eaten raw, cooked, or juiced, and are used in various culinary dishes and recipes. Carrots are easy to grow, making them a popular crop for home gardeners and farmers alike.

Soil and Climatic Requirements: Carrots grow best in well-drained, loose soils that are rich in organic matter. The soil pH should be between 6.0 and 6.8. Carrots prefer cool weather and can tolerate temperatures between 15-20°C. They can be grown in a wide range of climatic conditions, but it's important to avoid extremes of temperature and moisture.

Commercial Varieties: There are many varieties of carrots available, ranging in color from white to deep purple.

Some popular varieties include Danvers, Nantes, Imperator, and Chantenay. Choose a variety that is well-suited to your growing conditions.

Propagation: Carrots are typically grown from seed. The seeds are small and should be sown shallowly, about 1/4 inch deep. They can be planted directly in the garden or started indoors and transplanted.

Planting Distance and Time: Carrots should be planted in rows spaced 12-18 inches apart, with the seeds planted about 2 inches apart within the row. The ideal time to plant depends on your climate, but in general, carrots should be planted in the spring or fall.

Manures and Fertilizers: Carrots don't require a lot of fertilizer, but they do benefit from a moderate amount of nitrogen. Too much nitrogen can cause the carrots to develop hairy roots. A well-balanced fertilizer can be applied before planting, or a side-dressing of nitrogen fertilizer can be applied when the carrots are about 3-4 inches tall.

Irrigation: Carrots require regular watering to grow properly, but it's important not to overwater them. The soil should be kept consistently moist but not waterlogged. Irrigate deeply and infrequently to encourage deep root growth.

Plant Protection: Carrots can be susceptible to pests such as carrot rust fly and carrot weevil. These pests can be controlled with insecticidal sprays or by using row covers. Carrots can also be affected by foliar diseases such as leaf blight and powdery mildew, which can be controlled with fungicidal sprays.

Diseases: Carrots are susceptible to several diseases, including damping off, leaf blight, and powdery mildew. It's important to practice good sanitation practices and rotate crops to avoid the buildup of disease pathogens in the soil.

Physiological Disorders: Carrots can be affected by several physiological disorders, including cracking, splitting, and forked roots. These disorders can be caused by uneven watering, soil nutrient imbalances, and other factors.

Maturity and Harvesting: Carrots are ready to harvest when the roots are mature and of a usable size. This usually takes around 70-80 days after planting. The tops of the carrots will start to push up out of the soil when they are ready to be harvested. The carrots can be pulled up by hand, taking care not to damage the roots. The tops should be cut off and the carrots should be stored in a cool, dry place.

POTATO

Potato (Solanum tuberosum L.) is a member of the Solanaceae family and is considered a staple food in many European countries. It is a valuable source of starch and an important dietary component. Potatoes are rich in carbohydrates, vitamins (B1, B2, B6, and C), minerals (calcium, phosphorus, and iron), and protein.

Soil and Climatic Requirements: It can grow in almost all types of soil. The well-drained clay-loam soil is considered as ideal for its cultivation.

It is a cool season crop and can tolerate moderate frost. It requires 20°C soil temperature for better germination. Young plant growth is good at 24°C but later growth is favoured by a temperature of 18°C. No tuberization takes place when the night temperature exceeds 23°C. Maximum tuberization occurs at 20°C. Tuber formation stops completely at about 29-30°C.

Varieties

Early varieties: These varieties are ready for harvest in 70-80 days such as Kufri Ashoka, Kufri Chandermukhi, Kufri Jawahar, and Kufri Lauvkar.

Main season varieties: They are ready for harvest in 90-95 days. Among the white coloured varieties, Kufri Jyoti, Kufri Sutlej, Kufri Pukhraj, Kufri Megha, Kufri Badshah, Kufri Anand, Kufri Bahar, Kufri Sadabahar, Kufri Deva, Kufri Sherpa are important.

Late varieties: Kufri Jeevan, Kufri Neelamani, Kufri Khasigaro, Kufri Naveen.

Processing varieties: Kufri Chipsona 1, Kufri Chipsona 2, Kufri Chipsona 3, and Kufri Himsona.

Soil Preparation and Planting: A well prepared soil provides sufficient room for the development of tubers and also helps to retain moisture. The fields are ploughed to a depth of 20-35 cm first with soil turning plough and afterwards by 4 to 5 ploughings with country plough/disc harrow. Clods must be broken to make the field well pulverized and levelled.

Planting Time

Region	Season	Planting time	Harvesting time
North western hills			
Very high hills	Summer	April-May	September-October
High hills	Summer	Mid-March-April	September-October
Mid hills	Spring	Jan-February	May-June
North western plains	Early	Mid-September	Mid November-December
	Autumn	Mid-October	February-March
	Spring	January	April
North Central Plains	Winter	Mid-October	February-March
North eastern plains	Winter	October end to 2nd week of November	January-February

Seed Rate and Propagation: 25-35 q tubers/ha. Potato is traditionally propagated through tubers. The eyes on the

tuber surface contain axillary buds. The tubers have a dormancy of nearly 8-10 weeks after harvesting. The axillary buds on the tubers start germinating by producing sprouts only when this dormancy is over. The sprouted tubers put up fast and vigorous growth when planted in the soil.

Breaking of Dormancy: This dormancy can be broken by dipping cut tubers for 1-1½ hours in thiourea @ 1-2% solution or treating tubers with 5 ppm solution of GA3 for 10 seconds.

Seed Size and Spacing: Planting 40-50 g tuber with 40-50 mm diameter at a spacing of 45-60 cm between rows and 20-25 cm between the tubers within the rows. Tuber cutting is not recommended especially for the production of a seed crop as it transmits viruses and bacteria.

Manures and Fertilizers: Apply farmyard manure @100q/ha at the time of field preparation. However, fertilizers are applied @ 120:80:60 kg N: P_2O_5: K_2O/ha, respectively. Full dose of farmyard manure, phosphorus and potassium and half of N should be applied at the time of planting. Remaining part of N should be top dressed at the time of earthing up for effective utilization by the crop.

Irrigation: Water is applied effectively and economically at critical stages in crop development i.e. stolon formation, tuber initiation and tuber development stages of the crop. Irrigation is stopped about 10 days before harvesting of crop, to allow firming of tuber skin.

Plant Protection

Major diseases and their management		
Early blight	Concentric rings of brown to black colour are formed on the leaves. Heavily infected leaves fall off after drying. Spots also appear on stems.	Destroy crop debris. Spray ridomil MZ @ 2g/l or 0.3% blitox or 0.25% dithane - M - 45 / dithane - Z - 78 at fortnight intervals 3-4 times. Grow resistant varieties e.g. Kufri Naveen, Kufri Jeevan.
Late Blight	Lower leaves are infected having cottony growth. Water soaked lesions appear on the margins. Tubers decay under severe infection.	Use disease-free seed. Spray ridomil @ 2g per litre of water. Grow resistant varieties like Kufri Jawahar, Kufri Himsona, Kufri Jyoti, Kufri Swarnima, Kufri Kanchan.
Insect-pests and their management		
Cut worm	Adult moths cause extensive damage by cutting the plants.	Flood the infested fields, hand pick and destroy the larva, set up light trap @ 1/ha or pheramone traps @ 10/ ha to attract male moths and spray insecticides or chlorpyriphos 20EC @ 1 lit/ha or neem oil 3% @ 5.0ml/lit.
Potato tuber moth	It causes damage to tubers in the field and storage by tunneling the foliage, stem and tubers.	Avoid shallow planting of tubers, plant the tubers at depth of 10-15 cm, collect and destroy the infested tubers, and fumigate the stores with carbon disulphide.

Harvesting and Yield: The crop is harvested when it is fully matured, which can be characterized by yellowing of haulms and no pulling out of skin on rubbing of tubers. At the time of harvesting, field should not be too wet or too dry. Tractor operated potato diggers are available for digging the tubers from the fields. Early varieties may produce 200 q tubers/ha, and late varieties produce about 300 q tubers/ha.

ONION

Onion is a widely cultivated vegetable belonging to the Allium genus, which also includes garlic, chives, and leeks. It is grown for its edible bulbs, which can be eaten raw or cooked, and is used in a variety of dishes around the world. Onions are a popular crop due to their adaptability to different growing conditions and long storage life. They are also valued for their health benefits, as they are a good source of vitamins and minerals, including vitamin C, folate, and potassium. Onions can be grown in a variety of climates and soil types, making them a versatile crop for farmers and gardeners.

Soil and Climatic Requirements: Onions require well-drained soil with high organic matter content. They grow best in a soil pH range of 6.0 to 7.0. Onions grow well in cool climates, with a temperature range of 13°C to 30°C. They require plenty of sunlight and can tolerate light frost.

Commercial Varieties: Some of the popular varieties of onions are Red Creole, Texas Grano, White Bermuda, Yellow Granex, and Sweet Spanish.

Propagation: Onion seeds are sown in nurseries, and after 4-6 weeks, the seedlings are transplanted in the field. Onion can also be propagated through sets or small bulbs.

Planting Distance and Time: Onion seedlings are transplanted at a distance of 15cm x 15cm in rows 30cm apart. Planting is done during the cool season, between October and February.

Manures and Fertilizers: Onion plants require nitrogen, phosphorus, and potassium. Farmyard manure or compost is added to the soil before planting. Nitrogen fertilizer is applied in split doses at 20, 40, and 60 days after transplanting.

Irrigation: Onions require frequent and light irrigation, especially during the bulb formation period. The soil must be kept moist, but not waterlogged, to avoid rotting.

Plant Protection: Onion plants are prone to damage by thrips, aphids, and mites. Insecticides and pesticides can be used to control these pests.

Diseases: Onion plants are susceptible to diseases such as purple blotch, white rot, and downy mildew. Crop rotation, proper irrigation, and the use of disease-resistant varieties can help prevent these diseases.

Physiological Disorders: Onion plants can also suffer from physiological disorders such as bolting, splitting, and sunscald. Adequate irrigation, planting at the right time, and proper fertilization can help prevent these disorders.

Maturity and Harvesting: Onion bulbs are ready for harvest when the leaves turn yellow and start to fall over. The bulbs are lifted from the soil and allowed to dry in the field for a few days. The dried bulbs are then trimmed and stored in a cool and dry place.

CAULIFLOWER

Cauliflower (Brassica oleracea var. botrytis) is a cruciferous vegetable that belongs to the same family as cabbage, broccoli, and kale. It is an annual plant that is widely cultivated for its edible white, purple or green head or curd, which is composed of tightly clustered flower buds. Cauliflower is a highly nutritious vegetable and is a rich source of vitamins, minerals, and antioxidants. It is a versatile ingredient that can be roasted, boiled, mashed, or added to stir-fries, soups, and curries. Cauliflower is believed to have originated in ancient Asia and has been cultivated for over 2,000 years. Today, it is grown in many parts of the world and is a popular vegetable in many cuisines.

Soil and Climatic Requirements: Cauliflower can be grown in all types of soil with good fertility and good water holding capacity. It prefers a soil reaction ranging from pH 6 to 6.5.

Climatic factors play an important role during transformation from vegetative to curding and curd development stages. Temperature range of 10-21°C is good for germination and favourable temperature range is 17-20°C. On the basis of maturity, cauliflower varieties have been grouped as under:

Maturity group	Nursery sowing	Transplanting time	Opt. temp. range for curding	Varieties
Early I (A) Sept. maturity (mid Sept-mid Nov.)	Mid May	July beginning	20-25 °C	Early Kunwari, Pusa Early Synthetic, Pant Gobhi-3, Pusa Meghna, Pusa Kartik Sankar
Early I (B) Oct. maturity (Mid Oct-mid Nov)	May end to Mid June	Mid July	20-25°C	Pusa Katki, Pusa Deepali, Pant Gobhi-2
Mid Early (II) Nov. maturity (Mid Nov-mid Dec)	July end	Sept beginning	16-20°C	Improved Japanese, Pusa hybrid-2, Pusa Sharad, Pant Gobhi-4
Mid late (III) Dec maturity (mid Dec-mid Jan)	Aug end	Sept end	12-16 °C	Pusa Synthetic, Pusa Subhra, Palam Uphar, KT-25, Pant Subhra, Pusa HimJyoti, Pb Giant 35, Pusa Paushja, Pusa Shukti
Late (IV) Snowball (Jan-March)	Sept end to mid Oct	Oct end-mid Nov	10-16 °C	Snowball 16, Pusa Snowball-I, Pusa Snowball K-1, Danla, Ooty-1

Seed Rate and Spacing: The seed requirement for raising nursery for early varieties is 600-750g per hactare and for late varieties is 300g per hectare area. Early varieties 45cm × 30cm and mid and late season varieties 60cm × 45cm.

Soil Preparation and Transplanting: The soil should be well prepared by ploughing first with soil turning plough and afterwards with 4 to 5 ploughings with country plough. The manure should be applied at the time of field preparation. Drainage is a problem for early and some times for mid season crop when rains coincide with cropping period. Therefore, early crop should be transplanted on ridges or raised beds while the mid and late cultivars can be planted on flat beds. Transplanting should be done during late afternoon to avoid losses due to sun heat.

Manures and Fertilizers: Mix 200-250 q FYM/ha at the time of field preparation. Application of nitrogen,

phosphorus and potash @ 120-180: 75-80: 60-75 kg per hectare, respectively is required to raise a healthy crop of cauliflower.

Irrigation: Cauliflower needs very careful irrigation that should be applied at right time and in sufficient quantity as both overwatering and insufficient irrigation are harmful to the standing crop. First light irrigation is given immediately after transplanting of the seedlings.

Maturity and Harvesting: The harvesting of curds is to be done as soon as the curds attain prime maturity and compactness. It is better to harvest little early than late if there is any doubt about the maturity. Delayed harvesting leads to the elongation of flowering stalk, loose, ricey, and fuzzy and over matured curds which deteriorates the quality of the curd. The curd should be cut-off with stalk along with sufficient number of jacket leaves to protect the curd. Severe trimming of leaves is to be done after unloading or before marketing.

Physiological Disorders

Buttoning: It means development of small curds or buttons. Planting of over-aged seedlings, which do not get sufficient time to initiate growth before transformation to curding or selection of wrong cultivars (planting early variety late) or root injury by insects or diseases result in buttoning.

Riceyness: A premature initiation of floral buds or elongation of peduncle stalk of inflorescence is characterized by riceyness. The curds are considered to be of poor quality for marketing. Temperature higher or lower than the optimum required for curding or application of high nitrogen results in riceyness.

Blindness: Blind plants are those, which are without terminal bud. They do not form curd. It is due to poor fertility of the soil or damage to the terminal portion during handling at the time of planting or by insects, diseases etc.

Whip tail: It is caused by the deficiency of molybdenum (Mo). Young plants become chlorotic and turn white particularly along the leaf margins. In older plants, the lamina of the newly formed leaves is irregular in shape and leaves have only a large bare midrib. This is because of this condition, the disorder is called as "Whip tail".

BRINJAL

Brinjal, also known as eggplant or aubergine (Solanum melongena) , is an important vegetable indigenous to India and belongs to the family Solanaceae. It is a rich source of nasunin, a potent antioxidant known to protect brain cells. Brinjal can be grown on a wide range of soils, from light sandy to heavy clay, with silt loam and clay loam being the preferred types. The ideal pH range for brinjal cultivation is 5.5-6.8. As a warm-season crop, it is vulnerable to severe frost and thrives in temperatures ranging from 21-29°C.

Important Varieties: Pusa Shymala, Pusa Purple Long, Pusa Purple Cluster, Pusa Kranti, Pusa Bhairav, Pusa Anmol, Arka Sheel, Arka Shirish, Arka Kusumkar, Arka Navneet Arka Keshav, Arka Neelkanth, Punjab Chamkila.

Nursery Sowing and Planting Time

Crop/ Region	Spring-summer crop	Rainy season crop	Autumn crop
Northern Indian (NI) plains	Nov (mid Jan-Feb)	Mar-May (April-June)	June-July (July-Aug)

Soil Preparation and Transplanting: Brinjal should be planted in well pulverized field by ploughing first with soil turning plough and afterwards with 4 to 5 ploughings with country plough.

Seed Rate and Spacing: 500-700g (OP), 350-400g (hybrids). Spacing for Dwarf varieties-60 × 45 cm and tall varieties- 90 × 60 cm.

Manures and Fertilizers: FYM @200-250 quintals per ha should be applied at the time of field preparation. In addition, apply 75-100 kg N, 50-60 kg phosphorus (P_2O_5) and 50-60 kg potassium (K_2O) per hectare.

Irrigation: Apply irrigation at an interval of one week in summer season and 10-15 days during winter.

Maturity Harvesting and Yield: Fruits should be harvested when they attain a good size, attractive colour and its surface should not loose its bright and glossy appearance. Timely harvesting of tender fruits increases the total growing period and number of pickings alongwith yield. The yield of open-pollinated varieties is 300-500 q/ha and of Hybrids, it is 600-800 q/ha.

Plant Protection

Diseases	Symptoms and management
Phomopsis blight	Portion of fruit is bleached and gives burning appearance. Seed treatment with thiram @3 gm per kg. Spray the crop in the nursery with dithane M-45. Grow resistant variety like Pusa Bhairav.
Bacterial wilt	Grow resistant varieties such as Arka Nidhi, Arka Keshav, Hisar Shyamal etc.
Little leaf	Caused by Mycoplasma and transmitted by leaf hoppers. The affected plants are shorter in structure. The leaves are malformed. Floral parts turn into leaf-like structures. No fruit bearing takes place.
Insect-pests and their Control	
Brinjal fruit and shoot borer	It is the most serious pest of brinjal crop. Plant shoots wilt and dry. Small holes appear below the calyx of fruits. Fruits are filled with frass. Grow resistant/tolerant varieties like Pusa Purple Cluster, Arka Kusumkar. Foliar application of carbaryl (0.1%)/ endosulfan (0.07%)/ fenvalerate (0.01%) is effective.

TOMATO

Tomato (Solanum lycopersicum) belongs to the Solanaceae family and is an essential ingredient in almost every Indian vegetable dish. The fruit of the tomato plant is used to make soup, juice, ketchup, puree, paste and powder. The red color of the tomato is due to the presence of lycopene pigment, which has anticarcinogenic properties. The orange color of the fruit is due to the presence of carotenoid pigment, which is a rich source of vitamin A.

Plant Growth Habit in Tomato: Tomato varieties are grouped into two broad categories based on their growth habit:

Determinate (Dwarf growth)	Indeterminate (Tall growth)
Inflorescence occurs more frequently on every internode until terminal ones are formed.	Inflorescence cluster occurs at every third internode.
Plant growth stops at terminal point with a flower cluster (self topping).	The main branch continues growing indefinitely with fruit formation until frost occurs.

Soil and Climatic Requirements: Well drained, fairly light fertile loam with a fair moisture holding capacity is the most ideal soil for tomato cultivation. Tomato is a warm season crop, which requires long season to produce a profitable crop and highly susceptible to frost. High temperature and high humidity favours development of foliar diseases. Night temperature is the critical factor in fruit setting; the optimum range is 15-20°C.

Varieties: Pusa Rohini, Pusa Early Dwarf, Pusa 120, Pusa Ruby, Pusa Sadabahar, Pusa Uphar, Pusa Sheetal, Pusa Gaurav, Arka Abha, Arka Vikas, Arka Saurabh, Arka Alok, Arka Abhijit, Arka Shreshtha, Arka Vardan, Arka Ananya, Kashi Amrit, Kashi Hemant, Kashi Sharad, Kashi Anupam, Kashi Vishesh are important varieties.

Hybrids: Kt-4, Pusa Hybrid 1, Pusa Hybrid 2, Pusa Hybrid 4, Arka Vardan, Arka Meghali, Arka Vishal, Arka Samrat, Kashi Hybrid 1, Kashi Hybrid 2 are some hybrids developed in our country.

Nursery Sowing & Transplanting Time in India

Crop/Region	Spring-summer	Autumn crop
North Indian plains	Late Nov (mid Jan)	July-Aug (Aug-Sept)
Eastern India	Nov (Late Dec)	Aug-Sept (Sept-Oct)

Nursery Raising: For better survival in the field, it is advisable to harden the seedlings. Plants are allowed to nearly wilt for 2-3 days before watering and this practice can be repeated two-three times. Such seedlings can withstand the extremes of temperature. Seedlings become ready for transplanting in 4-5 weeks time. Seedlings 5mm in diameter are better and about 15cm in length are the best for transplanting.

Soil Preparation and Transplanting: Tomato should be planted in well pulverized field by ploughing first with soil turning plough and afterwards with 4 to 5 ploughings with country plough. Ploughing should be followed by leveling. Tomato is normally planted in raised beds of 60-75 cm width. Transplanting should be done during late afternoon and the seedlings are placed on side of the beds. This provides ample moisture for the plants to survive.

Seed Rate and Spacing: For pen pollinated varieties 400-500g and for hybrids = 150-200g. Spacing of 60 cm × 45cm for determinate varieties & 90cm × 30cm for indeterminate varieties.

Manures and Fertilizers: Recommended dose of N, P and K fertilizers and their time of application is as under.

Recommended dose	Farmyard manure (q/ha)	Nitrogen (Kg/ha)	Phosphorus (Kg/ha)	Potassium (Kg/ha)
Open pollinated varieties	250	75-100	50-75	50-60
Hybrids	250	150-180	100-150	80-120

Irrigation: Careful irrigation is required for better growth of tomato crop which should be sapplied at right time. Both over-watering and insufficient irrigation is harmful. Irrigation of tomatoes can result in higher and more consistent yields, better quality, larger fruit, less blossom-end rot and less cracking. Recent research on processing tomatoes in Ontario has shown yield increases of up to 81% on a range of soil types with the use of properly scheduled irrigation. Tomato yields increased with irrigation in both wet and dry years and on sandy soils as well as on clay loams. On light soils, with their low water-holding capacity, the tomato crop can be very responsive to irrigation, but correct scheduling will provide maximum benefit. Proper scheduling is critical when irrigating tomatoes on heavier soils.

Maturity and Harvesting: Tomato fruits are harvested at different maturity stages depending upon the purpose for which these are used and distance over which they are to be transported. Fully developed mature green fruits are harvested for long distance transportation. Such fruits ripen after reaching the market and develop good colour under favourable conditions. Fruits at turning stage (1/4th of the fruit especially at blossom end shows pink colour), pink stage (3/4th of the surface shows pink colour) and hard ripe stage (nearly all red or pink with firm flesh) are harvested for local market. Over ripe fruits (Fully coloured and soft) are suitable for processing, which ensure desired quality and red colour in processed products.

Major diseases and their management		
Damping Off	The fungus attack usually starts on the germinating seed, and further spread to the hypocotyl, basal stem, and developing tap- root.	Drench the nursery bed with 5 litre formalin dissolved in 100 litres of water 15 days before sowing. Spray mancozeb or dithane- M-45 (25 gram in 10 litre of water), carbendazim or bavistin (10 gram in 10 litre of water) on nursery seedlings.
Bacterial wilt	Deadly disease of tomato, which results in wilting of plant, stunting plant growth, yellowing of entire plant, and brown vascular system	Follow crop rotation with Cruciferous vegetables, grow resistant varieties such as Arka Ananya, Arka Rakshak *etc.*, follow hot water seed treatment at 50°C for 25 minutes and spray with streptocycline @ 200ppm at 4-7 days interval.
Insect-pests and their management		
Tomato fruit borer	Initially, the larvae feed on tender foliage but later on, it moves to flower buds, flowers and developing fruits. The caterpillars make holes into fruits and render them unfit for market.	Follow late transplanting. Foliar application of endosulfan (0.07%)/ carbaryl (0.1%)/ deltamethrin (0.0028%) and acephate (0.05%) is effective.
Fruit fly	The maggots after hatching feed on pulp of the fruits and render them unfit for human consumption.	Remove and destroy affected fruits. Use pheromone traps for monitoring pest population. Spray of fenthion (0.05%)/ fenitrothion (0.05%), or bait spray adding 50 g gur + 10 ml malathion in 10 L water is effective.
Physiological disorders and their management		
Blossom end rot	A very common and destructive disorder. Rotting of fruits starts at blossom end of the fruit. Deficiency of Mg and Ca is the main cause.	It can be managed by spraying calcium chloride @ 0.5% at fruit development stage. Also apply balanced irrigation and ensure proper staking.
Cracking of fruits	Cracking of fruits at stem end is common in tomato and often results in large losses. Cracks appear to develop at maturity or ripening stage than mature green or turning stage. Deficiency of boron and long dry spell followed by heavy watering are the main reason of cracking.	Soil application of 20-30 kg of borax per hectare is beneficial. Application of proper irrigation at right stage is also very important.

SPINACH

Spinach (Spinacia oleracea) is a popular leafy green vegetable that is rich in vitamins, minerals and antioxidants. It is a cool-season crop that can be grown year-round in some regions. Here are some details about the climatic and soil requirements, varieties, soil preparation and planting, seed rate and propagation, plant protection, harvesting and yield of spinach.

Soil and Climatic Requirements: Spinach prefers to grow in a well-drained, fertile soil with a pH level between 6.0 to 7.5. It grows best in cool temperatures ranging from 15 to 20°C. High temperatures and long day lengths may cause bolting in the plants.

Varieties: There are several varieties of spinach available. Some popular varieties include Bloomsdale, Savoy, New Zealand, and Indian Summer.

Propagation: Spinach is typically propagated from seeds, which can be sown directly into the soil or started indoors and transplanted later. The seeds should be sown about 1 cm deep and 3-5 cm apart. Spinach seeds typically take about 5-14 days to germinate.

Planting Distance and Time: Spinach can be grown year-round in most climates, but it grows best in the cooler months. The ideal planting distance for spinach is 10-15 cm apart in rows that are spaced about 30-40 cm apart.

Pruning: Spinach doesn't require any pruning. However, you can remove any damaged or diseased leaves to prevent the spread of disease.

Manures and Fertilizers: Spinach requires a moderate amount of nitrogen, phosphorus, and potassium for healthy growth. Before planting, it is recommended to add well-rotted manure or compost to the soil. Once the plants are established, you can feed them with a balanced fertilizer every 2-3 weeks.

Irrigation: Spinach requires consistent moisture to grow well. It is important to water the plants regularly, especially during dry periods. Overhead irrigation should be avoided as it can increase the chances of disease.

Plant Protection: Spinach is susceptible to several pests and diseases, including aphids, leaf miners, and downy mildew. To protect the plants, it is important to keep the garden clean and remove any debris or dead leaves.

Diseases: Some common spinach diseases include downy mildew, powdery mildew, and white rust. These diseases can be prevented by practicing good sanitation practices, proper watering techniques, and using disease-resistant varieties.

Physiological Disorders: Spinach can suffer from physiological disorders such as bolting, tipburn, and yellowing. These disorders can be prevented by providing proper growing conditions such as cool temperatures, adequate water, and proper fertilization.

Maturity and Harvesting: Spinach typically reaches maturity in about 40-50 days after planting. The leaves can be harvested when they are young and tender, usually about 3-4 weeks after planting. Spinach can be harvested by cutting the leaves just above the soil level or by pulling the entire plant out of the ground.

CABBAGE

Cabbage (Brassica oleracea var. capitata) is a leafy vegetable belonging to the Brassicaceae family, and is widely cultivated throughout the world. It is an excellent source of vitamins, minerals, and dietary fiber. Cabbage is available in different colors, including green, red, and purple, and can be consumed cooked or raw, in salads, soups, stews, and a variety of other dishes. The cultivation of cabbage is a major agricultural activity in many countries, with China being the largest producer followed by India and Russia.

Varieties

Early Group: It takes 55-70 days for maturity. The commonly grown varieties are Golden Acre, Pride of India, Copenhagen Market, Pusa Ageti, Pusa Mukta, Pusa Sambandh (Synthetic variety).

Mid season Group: The cultivars fall between early and late maturity groups in September. Pusa Drum Head is the common variety from this group.

Late Group: It takes about 85-130 days for maturity e.g. Late Large Drum Head.

Soil and Climatic Requirements: The soil requirement for cabbage is almost same as that of cauliflower. On heavy soils, plant grows slowly and the keeping quality is improved because of compactness. Most cabbages are some what tolerant to salt. It can withstand extreme cold and frost better than cauliflower.

Planting Time: In the Northern Indian plains, transplanting of different varieties can be done from October-January.

Seed Rate and Spacing: Early season varieties need 600-800 g/ha & main season varieties need 200-500 g/ha. Late varieties 60 cm × 45 cm & for early varieties 45 cm × 30 cm.

Nutrient Management: Mix 200-250 q/ha farmyard manure thoroughly at the time of field preparation. Application of 120-180 kg nitrogen, 75-80 kg phosphorus and 60-75kg potassium per hectare is required to raise a healthy crop of cabbage.

Water Management: Cabbage is very sensitive to soil moisture. Irrigation may be applied at 10-15 days interval according to the season and soil but optimum soil moisture should be maintained regularly.

Maturity and Harvesting: In general, the heads are harvested when they are firm and solid. The heads are cut with a knife, frequently attached with some non-wrapper leaves. These non-wrapper leaves give protection to the heads from bruising injury.

Diseases and Insect-pests of Cole Crops

Major diseases and their management		
Black leg	It is a seed borne disease and hence infest crop plants at an early stage. Stem of the affected plant shows severe black discolouration. Whole root system decays from bottom upwards. Often, the affected plants collapse in the field.	Hot water treatment of seed before sowing. Spray the seed crop with copper oxychloride or with an organomercuric compound. Grow resistant varieties like Pusa Drum Head.
Downy mildew	It causes serious damage at all stages of plant growth. Discolouration occurs in the young seedlings and in severe cases, whole plant perishes.	Spray ridomil @ 0.5 g/litre of water at 10-15 days intervals or with dithane-M-45 @ 1.5-2.0 g/ litre of water.
Black rot	The tissue at the leaf margin becomes yellow; chlorosis progresses towards leaf center creating a V-shaped area at the mid rib.	Spray streptocycline @ 5g and blitox @ 100g per 10 litre of water after transplantation.
Bacterial soft rot	The affected plants show a soft, slimy, bad smelling rot that rapidly spreads throughout the plant under favourable conditions.	Control measures adopted for other diseases can check this disease as well. Spray 100- 200 ppm streptocycline or plantomycin combined with copper oxychloride (0.3%) at 15 days interval.

Insect- pests and their Management		
Diamond back moth	Spindle shaped pale yellowish green caterpillars feed on the lower side of leaves but later feed on the exposed leaves and enter the head/ curd affecting the produce as well as quality.	Grow Indian mustard as a trap crop. Spray of malathion (0.05%) or deltamethrin (0.028%), or cypermethrin (0.0075%) is very effective.
Aphids	Aphids cause serious damage by sap sucking. Seed setting stage is seriously affected.	Foliar application of malathion (0.05%) at 15 days interval is quite effective.
Cabbage butterfly	Damage is caused by caterpillars. The white winged butterflies deposit yellow coloured eggs in clusters on the undersurface of leaves.	Collect and destroy yellow egg masses and early stage larvae of cabbage butterfly. Spray of malathion (0.05%)/ deltamethrin (0.0028%)/ cypermethrin (0.0075%) and fenvalerate (0.01%) is quite effective.

GLADIOLUS

Gladiolus is a genus of flowering plants in the family Iridaceae. The plant is native to South Africa, but it is widely cultivated around the world for its attractive flowers. Gladiolus plants produce tall, graceful spikes of colorful blooms that are popular in cut flower arrangements and as garden plants. The flowers come in a wide range of colors, including pink, red, purple, yellow, orange, and white, and can be single or double blooms. The plant is easy to grow and care for, making it a popular choice for home gardeners and florists alike. In addition to its ornamental value, the Gladiolus has also been used in traditional medicine for its healing properties.

Soil and Climatic Requirements: Gladiolus plants thrive in well-drained soils that are rich in organic matter. The ideal pH range for soil is 6.0-7.0. Gladiolus plants require full sunlight exposure for proper growth and development. They can tolerate a wide range of temperatures, from 15-35°C, but grow best in warm and dry conditions.

Varieties: There are many gladiolus varieties available, which vary in size, color, and shape of the flowers. Some of the popular varieties are Atom, Black Star, Blue Bird, White Prosperity, Friendship, and Green Star.

Propagation: Gladiolus can be propagated through corms, which are underground stems that are similar to bulbs. Corms should be planted in well-draining soil, and the pointed end should be facing upwards. Corms can be planted directly in the ground, or in pots or containers.

Planting Distance and Time: Gladiolus should be planted in rows, with a spacing of 15-20 cm between plants and 60-90 cm between rows. The best time for planting is in early spring, after the danger of frost has passed. Planting can continue until early summer.

Pruning: Gladiolus plants require regular pruning to promote healthy growth and blooming. Dead or damaged flowers should be removed promptly to prevent the development of fungal diseases.

Manures and Fertilizers: Gladiolus plants require regular feeding with balanced fertilizers to promote healthy growth and blooming. A slow-release fertilizer can be applied at planting time, and a liquid fertilizer can be applied every 2-3 weeks during the growing season.

Irrigation: Gladiolus plants require regular watering, particularly during dry periods. They should be watered deeply once a week, or more often if the weather is hot and dry. However, care should be taken not to overwater, as gladiolus plants are susceptible to root rot.

Plant Protection: Gladiolus plants are susceptible to a number of pests and diseases, including thrips, spider mites, and fungal diseases such as botrytis and fusarium wilt. Regular monitoring and early intervention can help prevent serious damage.

Diseases: Gladiolus plants can be affected by a number of diseases, including botrytis, fusarium wilt, and rust. Good cultural practices such as regular pruning, proper spacing, and adequate irrigation can help prevent the development of these diseases.

Physiological Disorders: Gladiolus plants can also be affected by a number of physiological disorders, including stem rot, corm rot, and streaking. These disorders can be prevented by maintaining good soil drainage and avoiding overwatering.

Maturity and Harvesting: Gladiolus flowers are ready for harvesting when the first few flowers on the spike have opened. The spikes should be cut when about half of the flowers on the spike have opened. Flowers can be stored in a cool, dry place for several days before use.

CANNA

Canna is a genus of perennial flowering plants native to tropical and subtropical regions of the Americas, although some species are also found in Africa and Asia. These plants are widely grown for their colorful and attractive flowers, as well as their lush foliage, which can range from green to purple or bronze. Canna plants have been cultivated for centuries and have been hybridized extensively, resulting in a wide variety of cultivars with different flower colors, sizes, and shapes. They are often used in garden beds, borders, and containers, and can also be grown as

houseplants. In addition to their ornamental value, some species of canna are also used for medicinal purposes, while others are cultivated for their edible rhizomes.

Soil and Climatic Requirements: Canna plants grow well in well-drained soil rich in organic matter with a pH range of 5.5 to 7.0. They require warm temperatures and plenty of sunlight to thrive. The ideal temperature range for canna cultivation is between 20 to 30°C (68 to 86°F). In areas with hot summers, it's best to plant them in partially shaded locations to protect them from the intense heat.

Varieties: There are many varieties of canna, with different colors and sizes. Some popular varieties include Canna indica, Canna 'Australia', Canna 'Durban', Canna 'Pink Sunburst', Canna 'Pretoria', and Canna 'Tropicanna'.

Propagation: Canna can be propagated through rhizomes or seeds. Rhizomes are the most common method of propagation. To propagate through rhizomes, separate the clumps of rhizomes during the dormant season, making sure each section has a bud. Plant the rhizomes 4 to 6 inches deep in well-prepared soil.

Planting Distance and Time: Canna plants should be planted 18 to 24 inches apart and 4 to 6 inches deep. They can be planted in the spring, after the last frost has passed, or in the fall. Planting in the fall allows for earlier blooming in the following year.

Pruning: Canna plants don't require much pruning, but deadheading spent flowers can promote additional blooms. Cut the flower stem down to the base of the plant after the flowers have faded.

Manures and Fertilizers: Canna plants benefit from regular feeding. A balanced fertilizer can be applied once a month during the growing season. Organic matter, such as compost or well-rotted manure, can also be added to the soil to provide nutrients.

Irrigation: Canna plants require regular watering, especially during hot and dry periods. They should be watered deeply, but not overwatered, as they don't tolerate waterlogged soil. Mulching around the plants can help to retain moisture in the soil.

Plant Protection: Canna plants can be susceptible to pests such as slugs, snails, and spider mites. Regular monitoring and removal of pests can help to prevent damage. Diseases such as fungal leaf spot and bacterial wilt can also affect canna plants. Avoid overhead watering and remove infected plant material to prevent the spread of disease.

Physiological Disorders: Canna plants can be prone to a condition known as canna rust. This is characterized by yellowing leaves with brown spots. It can be prevented by avoiding overhead watering and ensuring good air circulation around the plants.

Maturity and Harvesting: Canna plants will begin to flower in mid-summer and continue until the first frost. Flowers can be cut for use in floral arrangements when the lower blooms start to fade. The rhizomes can be dug up in the fall after the foliage has died back, dried, and stored for planting the following year.

CHRYSANTHEMUMS

Chrysanthemums are flowering plants that are native to Asia and northeastern Europe. They are widely cultivated as ornamental plants and are valued for their brightly colored, long-lasting blooms. Chrysanthemums are known for their variety of shapes and sizes, ranging from small, daisy-like flowers to large, showy blooms resembling pom-poms or spiders. They are commonly used in gardens, landscapes, and as cut flowers for floral arrangements.

Chrysanthemums have been cultivated for thousands of years and have a rich cultural history, particularly in East Asia where they have been used for medicinal and culinary purposes. Today, there are hundreds of cultivars of chrysanthemums available, each with its unique characteristics and growing requirements.

Soil and Climatic Requirements: Chrysanthemums prefer well-drained loamy soils with a pH of 6.0 to 7.5. They grow well in moderate temperatures ranging from 15 to 28°C. However, they can also tolerate low temperatures up to –5°C and high temperatures up to 35°C. These flowers need a lot of sunlight to grow, but they also require shade during the hottest part of the day. They can grow in both tropical and temperate regions.

Varieties: There are several types of chrysanthemums, including garden chrysanthemums, spray chrysanthemums, and exhibition chrysanthemums. The garden chrysanthemums are the most common type and are easy to grow. They come in different colors and flower shapes, including pompons, spider-like flowers, and daisy-like flowers.

Propagation: Chrysanthemums can be propagated from seeds, cuttings, and division of the roots. Seeds are sown in a nursery bed and transplanted when they are 6 to 8 weeks old. Cuttings are taken from mature plants and planted in a rooting medium. The roots division method involves dividing the roots of mature plants and replanting them.

Planting Distance and Time: The planting distance for chrysanthemums depends on the variety and the growing conditions. Generally, garden chrysanthemums should be planted 18 to 24 inches apart, while spray chrysanthemums should be planted 10 to 12 inches apart. They can be planted in spring or fall, depending on the climate.

Pruning: Pruning is essential for the growth and development of chrysanthemums. Pinching off the tips of the growing stems will encourage bushy growth and more

flowers. Deadheading or removing faded flowers can also help promote more blooms.

Manures and Fertilizers: Chrysanthemums require a balanced fertilizer with a higher amount of phosphorus and potassium than nitrogen. A well-decomposed organic manure, such as compost or well-rotted manure, can be added to the soil to improve its fertility.

Irrigation: Chrysanthemums need regular watering, especially during the hot and dry season. Overwatering can lead to root rot and other diseases, so it's important to avoid waterlogging the soil. Drip irrigation is the best method for watering chrysanthemums.

Plant Protection: Chrysanthemums can be affected by pests such as aphids, spider mites, and thrips. They can also be susceptible to diseases such as powdery mildew, botrytis, and bacterial leaf spot. Proper sanitation practices, including removing plant debris and dead leaves, can help prevent the spread of diseases.

Physiological Disorders: Chrysanthemums can develop physiological disorders such as stem breakage, bud blast, and chlorosis. These can be caused by factors such as improper watering, nutrient deficiencies, and environmental stresses.

Maturity and Harvesting: Chrysanthemums bloom in the fall and can be harvested when the flowers are fully open but before they start to fade. The flowers should be cut in the morning and placed in a bucket of water immediately to keep them fresh. They can be stored in a cool place for up to two weeks.

ROSE

Rose (Rosa species) is a well-known and popular flower that has been cultivated for centuries around the world. In India, it is widely grown for commercial purposes, especially for cut flowers that are sold in traditional flower markets and florist shops. The loose petals of roses are also used for making garlands and for offering in temples, while cut roses with stems are primarily used for creating beautiful bouquets and floral arrangements. In addition to the commercial rose, the Damask rose (R. damascena) and Edouard rose (R. bourboniana) are grown for their attar and other products such as gulkand, gulabjal, and pankhurj.

Soil and Climatic Requirements: Roses are grown in cold climate of the hills as well as in the plains of northern and southern regions and well-drained, medium loam soil having a pH of 6.0–7.5 is ideal for rose growing.

Varieties: First Red, Grand gala, Gladiator, cocktail.

Propagation: Rose is commercially propagated through T-Budding.

Planting: The rose should be planted in pits of 60 cm diameter and 60–75 cm depth dug at appropriate distances in a bed and in northern plains, mid-October is good time for planting.

Pruning: The rose bushes are pruned once a year during second or third week of October in the northern plains. After about 6–7 weeks of pruning, the plants start flowering. The time of flowering can be adjusted according to the date of pruning. The pruning in northern plains, is done in October.

Manuring and Fertilization: Rose being a perennial crop, it requires regular nutrient feeding through manures and fertilizers at the time of pruning, plant growth and at the end of flowering, besides during land preparation and planting of new bushes.

Irrigation: The frequency of irrigation depends upon the soil texture and climate. Watering is more frequent in sandy soils and hot weather than in clay soils and humid/ rainy or cool season. During the rainy season in eastern/ southern or coastal areas, it may not be necessary to irrigate the plants. The frequency of watering during summer may be about twice a week, while in winter or cool season, it may be only once a week or 10 days.

Disbudding and Pinching: The young vegetative buds in the leaf axils of basal and lateral shoots are disbudded to encourage branching at the base and to obtain long terminal shoots. For obtaining long stemmed quality blooms, it is necessary to do disbudding and pinching or removal of side flower buds.

Harvesting and Postharvest Management: The rose flowers are cut while still in the bud stage after the sepals curl back and the colour is fully showing. In large-flowered roses, flowers along with the stem of prescribed length are cut when the first one or two petals start to unfold but do not open fully. The flowers in small-flowered clustered varieties are cut when these begin to open in the cluster. The flowers are harvested in early morning or late in the afternoon.

The cut roses are kept in plastic buckets/containers filled with clean water having disinfectant and preservative (silver thiosulphate) to enhance their shelf-life. These flowers are shifted to precooling chambers having a temperature of 10°C, and kept there for about 12hr. The grading is done on the grading tables. The graded flowers are bunched with 10 or 20 stems in each bunch and sleeved with thick paper or plastic film. These flowers are then packed in telescopic corrugated cardboard boxes.

Plant Protection

Pests	Diseases
Red spider mite	Powdry mildew
Scale	Dieback
Aphid	Black spot
Leaf eating caterpillar	Nematode

MARIGOLD

Marigold (Tagetes spp.) is an ornamental crop belonging to the family Asteraceae. It is cultivated for its loose flowers, which are popular in the market as garlands or as cut flowers. In addition to its ornamental value, Marigold is also a source of pigment for poultry feed. Its variable height and colourful flowers make it a popular choice for landscape designs and beautification purposes.

Botanical Description:

1. Tagetes erecta (African marigold): The African marigold plant is hardy, annual; about 90 cm tall erect and branched.
2. Tagetes patula (French marigold): The French marigold is a hardy annual, about 30 cm tall, forming a bushy plant.

Soil and Climatic Requirements: Marigold is adaptable to different types of soil conditions and thus can grow successfully in a wide variety of soils. However, a deep, fertile, friable soil having good water holding capacity, well drained and near to neutral in reaction (pH 7.0 – 7.5) is most desirable. Marigold requires mild climate for luxuriant growth and flowering.

Varieties:

1. Tagetes erecta (African marigold): Pusa Narangi Gainda, Pusa Basanti Gainda, Climax, Chrysanthemum, Charm etc.
2. Tagetes patula (French marigold): Pusa Arpita, Red Brocade, Rusty Red, Butter Scotch etc.

Plant Propagation: Marigold is mainly propagated by seeds. The seed rate is 42.5 kg/ha.

Transplanting: Mid-July, mid-October and February-March are suitable times for transplanting of marigold at spacing of 40 × 30 cm.

Nutrient Management: FYM is given @ 50 tones/ha at the time of field preparation. In African and French marigold, application of 400 kg N, 200 kg P and 60 kg K per hectare should be done.

Maturity and Harvesting: Marigold flowers are plucked when they have attained full size. Plucking of flowers should be done in cool hours of the day. The field should be irrigated before plucking so that flowers keep well for a longer period after harvest. Plucked flowers are collected in polythene bags or bamboo baskets for carrying to markets.

Plant Protection

Pests	Diseases
Red spider mite	Damping off
Hairy caterpillar	Collar rot
Alternaria dianthi	Flower bud rot

PRINCIPLES AND METHODS OF PRESERVATION OF FRUITS AND VEGETABLES

Preservation of fruits and vegetables is an important practice to increase their shelf life and maintain their nutritional value. The principles and methods of fruit and vegetable preservation vary depending on the type of produce and the desired preservation method. Here are some common principles and methods of fruit and vegetable preservation:

Temperature Control

Temperature control is one of the most important principles in fruit and vegetable preservation. The rate of respiration and ripening of fruits and vegetables is directly related to temperature. Therefore, controlling the temperature of fruits and vegetables is essential in maintaining their quality, shelf life, and preventing spoilage.

Refrigeration is the most common method of temperature control in fruit and vegetable preservation. Lowering the temperature slows down the respiration and ripening processes and inhibits the growth of microorganisms. This method is most effective for storing fruits and vegetables that are sensitive to heat and moisture, such as leafy greens, berries, and citrus fruits. The ideal temperature for most fruits and vegetables in refrigeration is between 0°C and 5°C.

Another method of temperature control is freezing. Freezing is an effective method of preserving fruits and vegetables for extended periods of time. Freezing slows down or stops the enzymatic and microbial processes, thereby extending the shelf life of fruits and vegetables. The ideal temperature for freezing fruits and vegetables is below -18°C.

On the other hand, some fruits and vegetables are sensitive to cold temperatures and can suffer from cold damage or chilling injury. These include tropical fruits such as bananas, avocados, and mangoes, and vegetables such as tomatoes and cucumbers. Chilling injury can cause the fruits and vegetables to develop brown spots, lose flavor, and become less crisp. To prevent chilling injury, these types of fruits and vegetables should be stored at temperatures above 10°C.

In addition to refrigeration and freezing, other temperature control methods include canning and pasteurization. Canning involves heating fruits and vegetables in sealed containers to high temperatures to kill microorganisms and stop the enzymatic reactions. Pasteurization is a heat treatment that is used to destroy microorganisms and enzymes in fruit and vegetable products such as juices and purees. The temperatures used in canning and pasteurization vary depending on the type of fruit or vegetable and the product being produced.

Temperature control is a critical principle in fruit and vegetable preservation. Proper temperature management can extend the shelf life of fruits and vegetables, maintain their quality, and prevent spoilage.

Dehydration

Dehydration is a method of preserving fruits and vegetables that involves removing the moisture from the produce. By removing the moisture, the growth of microorganisms that cause spoilage is prevented. Dehydrated fruits and vegetables have a longer shelf life and are easy to store, transport and use.

Dehydration can be achieved through several methods, including sun drying, air drying, and mechanical drying. Sun drying is the oldest and most traditional method of dehydrating fruits and vegetables. In this method, the produce is spread out in the sun and allowed to dry naturally. This method is only effective in areas with high temperatures and low humidity, and can take several days to complete.

Air drying is another method of dehydration that can be used in any climate. In this method, the produce is cut into small pieces and spread out in a well-ventilated area, such as a screen or wire mesh. Air drying can take several days to complete, depending on the climate and the type of produce being dehydrated.

Mechanical drying is a faster and more efficient method of dehydration. In this method, the produce is dried using specialized equipment such as a dehydrator, oven or microwave. A dehydrator uses low heat and a fan to circulate the air and remove moisture from the produce. An oven can also be used to dehydrate fruits and vegetables by setting it to a low temperature and leaving the door slightly ajar. A microwave can be used for small batches of produce by placing the slices on a microwave-safe plate and cooking them on a low power setting for several minutes.

Before dehydrating fruits and vegetables, it is important to properly prepare them by washing, peeling and slicing them into even-sized pieces. This ensures that the produce is dried evenly and thoroughly. It is also important to store dehydrated fruits and vegetables in an airtight container in a cool, dry place to prevent moisture from re-entering the produce and causing spoilage.

Dehydrated fruits and vegetables can be rehydrated by soaking them in water for several hours before use. They can be used in a variety of dishes, including soups, stews, salads and baked goods. Dehydrated fruits can also be used as a healthy snack or in trail mix.

Canning

Canning is a preservation method that involves sealing fruits and vegetables in airtight containers, such as jars or cans, and heating them to destroy microorganisms that cause spoilage. The method was first developed in the 18th century, and since then it has become one of the most popular methods of fruit and vegetable preservation.

The basic principles of canning are as follows:

1. Preparation: Before canning, fruits and vegetables are washed, peeled, and cut into suitable sizes. Vegetables are often blanched, which involves boiling them for a short period of time and then immediately cooling them in ice water. This helps to preserve their color, texture, and nutrient content.
2. Filling: The prepared fruits and vegetables are then packed into clean, sterilized jars or cans. The containers must be filled with enough liquid, such as water, syrup, or brine, to cover the produce and allow for heat penetration during processing.
3. Sealing: Once the containers are filled, they are sealed with a lid or cap. The sealing process is essential to prevent the entry of air and microorganisms that could cause spoilage.
4. Processing: The sealed containers are then processed by heating them to a specific temperature for a specific amount of time. This process, known as thermal processing, kills any bacteria, yeasts, or molds that may be present, and also inactivates enzymes that can cause deterioration of the product. The specific processing time and temperature vary depending on the type of produce being canned.
5. Cooling: After processing, the containers are removed from the heat source and allowed to cool. As they cool, a vacuum is created inside the container, which helps to ensure a tight seal and prevent the entry of air.

Canning is an effective method of fruit and vegetable preservation, as it can extend the shelf life of produce for up to several years. The method also retains the color, texture, and flavor of the produce, and can provide a convenient and easy way to store and use fruits and vegetables year-round.

Fermentation

Fermentation is a traditional method of food preservation that has been used for centuries to preserve fruits and vegetables. Fermentation involves the use of microorganisms, such as bacteria or yeast, to convert the natural sugars in fruits and vegetables into organic acids, alcohols, and gases. These organic acids and alcohols can inhibit the growth of spoilage-causing microorganisms and help to preserve the fruits and vegetables for long periods.

There are several types of fermentation methods that are commonly used for fruit and vegetable preservation, including lactic acid fermentation, acetic acid fermentation, and alcoholic fermentation. Lactic acid fermentation is the

most common method of fermentation used for fruits and vegetables, and involves the use of lactic acid bacteria to convert the natural sugars in fruits and vegetables into lactic acid.

To carry out lactic acid fermentation, fruits and vegetables are first washed and then sliced, grated, or chopped into small pieces. Salt is then added to the fruits and vegetables to help draw out the natural juices and create an environment that is favorable for lactic acid bacteria. The fruits and vegetables are then packed into a fermentation vessel and left to ferment for several days to several weeks, depending on the type of fruits and vegetables and the desired degree of fermentation.

Acetic acid fermentation, also known as vinegar fermentation, involves the use of acetic acid bacteria to convert the natural sugars in fruits and vegetables into acetic acid. This method of fermentation is commonly used for the preservation of cucumbers, beets, and other vegetables.

Alcoholic fermentation involves the use of yeast to convert the natural sugars in fruits and vegetables into alcohol. This method of fermentation is commonly used for the preservation of fruits, such as grapes and apples, to make wine and cider.

Fermented fruits and vegetables are rich in probiotics, which are beneficial bacteria that can help to improve digestive health and boost the immune system. They are also a good source of vitamins, minerals, and antioxidants. Some common examples of fermented fruits and vegetables include sauerkraut, kimchi, pickles, and kefir.

Freezing

Freezing is a popular method of preserving fruits and vegetables, as it can retain the quality of the produce for an extended period. The principle behind freezing is that the low temperature inhibits or slows down the growth of microorganisms, which are responsible for spoilage. Freezing also helps to retain the natural color, flavor, and texture of the fruits and vegetables.

The process of freezing fruits and vegetables involves the following steps:

1. Selection of fresh and high-quality produce that is suitable for freezing.
2. Washing, trimming, and cutting the produce into the desired size and shape.
3. Blanching the produce in boiling water or steam for a short period, which helps to inactivate enzymes that cause loss of flavor, color, and texture.
4. Cooling the blanched produce immediately in ice water to stop the cooking process.
5. Draining the excess water and drying the produce.
6. Placing the produce in freezer bags or containers, and storing them at a temperature of –18°C or lower.

The duration of storage depends on the type of produce, as well as the temperature and conditions of storage. Generally, frozen fruits and vegetables can be stored for several months to a year. However, the quality of the produce may deteriorate over time due to factors such as freezer burn, which is caused by dehydration of the surface of the produce, and oxidation, which causes discoloration and loss of flavor.

To ensure the best quality of frozen fruits and vegetables, it is essential to follow proper freezing techniques and to use suitable packaging materials. The packaging should be airtight and moisture-resistant, and the size of the package should be appropriate for the amount of produce being frozen. It is also important to label the package with the type of produce, date of freezing, and storage instructions.

Freezing is an effective method of preserving fruits and vegetables, as it helps to retain the natural qualities of the produce and inhibit the growth of microorganisms. By following proper techniques for selection, preparation, blanching, packaging, and storage, frozen fruits and vegetables can be enjoyed for an extended period.

Vacuum Packing

Vacuum packing is a method of food preservation that involves removing air from a package to create a vacuum-sealed environment. This process helps to reduce the amount of oxygen in the package, which can slow down the growth of bacteria and fungi that can spoil food.

The vacuum packing process involves placing the food in a plastic bag or container and then using a vacuum sealer machine to remove the air from the package. The bag or container is then sealed, creating a tight seal that prevents air from re-entering the package.

One of the benefits of vacuum packing is that it can help to extend the shelf life of fruits and vegetables by slowing down the natural deterioration process. By reducing the amount of oxygen in the package, vacuum packing can help to slow down enzymatic reactions that can cause fruits and vegetables to become soft, mushy, or discolored.

Vacuum packing can also help to preserve the flavor and nutritional content of fruits and vegetables. By reducing the amount of exposure to oxygen, vacuum packing can help to reduce the oxidation of vitamins and other nutrients in the food.

Another benefit of vacuum packing is that it can help to reduce food waste. By extending the shelf life of fruits and vegetables, vacuum packing can help to prevent them from spoiling before they can be used, reducing the amount of food that goes to waste.

Vacuum packing is a useful method of fruit and vegetable preservation that can help to extend the shelf life of these perishable foods and reduce food waste.

Salting

Salting is a traditional method of preserving fruits and vegetables that involves adding salt to the produce to prevent spoilage. This method works by drawing out the water from the fruits and vegetables, which prevents the growth of bacteria and other microorganisms that cause decay. Salting is commonly used to preserve cucumbers, olives, and various types of cabbage.

The process of salting involves soaking the fruits or vegetables in a salt solution, also known as brine. The concentration of the brine and the length of time the produce is soaked in it depends on the type of produce being preserved and the desired level of saltiness. For example, cucumbers are typically soaked in a 5-10% brine solution for 1-3 weeks, while cabbage is soaked in a 2-3% brine solution for several weeks.

Once the produce has been soaked in the brine, it can be stored in airtight containers, such as jars or crocks, and kept in a cool, dark place. The salt acts as a natural preservative, extending the shelf life of the produce for several months or even years.

One advantage of salting is that it requires minimal equipment and can be done at home with relatively little effort. However, it is important to ensure that the produce is fully submerged in the brine to prevent spoilage. Additionally, some people may find the high salt content of salt-preserved produce to be undesirable from a health standpoint.

Salting is a simple and effective method of preserving fruits and vegetables that has been used for centuries.

The principles and methods of fruit and vegetable preservation are diverse and can be adapted to suit different types of produce and preservation goals. The choice of method depends on factors such as the type of produce, desired shelf life, and preservation method.

PREPARATION OF JELLIES, JAMS, KETCHUP, CHIPS AND THEIR PACKING

Preparation of jellies, jams, ketchup, chips, and their packing involve different processes and techniques. Here are some details on each:

Jellies

Preparation of jellies involves cooking fruit juice with sugar and pectin, which is a natural thickening agent found in many fruits. The process of making jellies involves the following steps:

1. Fruit preparation: Choose ripe, high-quality fruits that are free of blemishes and bruises. Wash and remove any stems, pits, or seeds, and chop or crush the fruit as needed.
2. Mixing: Combine the fruit with sugar and any other desired ingredients in a large pot or kettle. Pectin may be added to help the mixture set.
3. Cooking: Heat the mixture over medium heat, stirring frequently, until the sugar dissolves. Increase the heat to bring the mixture to a boil, and continue cooking until the mixture reaches the jelling point. This can be determined by using a thermometer or performing a plate test.
4. Skimming: Remove any foam or scum that forms on the surface of the jelly as it cooks.
5. Filling and processing: Pour the hot jelly mixture into sterilized jars, leaving a small amount of headspace at the top. Seal the jars with lids and bands, and process them in a water bath canner for the recommended time.
6. Cooling and storage: After processing, remove the jars from the canner and allow them to cool on a towel or rack. Check that the lids have sealed properly and store the jars in a cool, dry place.

Jellies can be made with a variety of fruits, and different flavorings and spices can be added for variety. Jellies can also be made without added pectin, by using fruits that are naturally high in pectin, such as apples or quince.

The packing of jellies is an essential step in the process of making jellies. Proper packing ensures that the jellies are protected from contamination and that they remain fresh and flavorful for a longer period of time.

The following are the steps involved in packing jellies:

1. Sterilize the jars: Before packing the jellies, it is important to sterilize the jars. This can be done by washing the jars and lids in hot, soapy water and then boiling them for 10 minutes.
2. Fill the jars: Once the jars are sterilized, fill them with the hot jelly mixture using a ladle, leaving about 1/4 inch of space at the top.
3. Remove air bubbles: To remove any air bubbles, run a plastic or wooden spatula around the inside of the jar.
4. Wipe the rim: Wipe the rim of the jar with a clean, damp cloth to remove any spills or drips.
5. Place the lid: Place the lid on the jar and screw the band tightly.
6. Process the jars: Process the jars in a boiling water bath for the recommended time based on the recipe.
7. Cool and store: Once processed, remove the jars from the water bath and allow them to cool on a wire rack. Check the seals of the jars to ensure they are properly sealed. Label the jars with the date and store them in a cool, dry place.

Proper packing of jellies helps to preserve the quality and shelf life of the product.

Jams

Preparation of jams involves the following steps:

1. Selection of fruits: The first step in preparing jams is the selection of ripe, fresh and high-quality fruits. The fruit should be free from any mold, bruises, or damage.
2. Washing and preparation: The fruits are washed thoroughly and then peeled, cored, and cut into small pieces. Some fruits, such as berries, can be mashed instead of cut.
3. Cooking: The prepared fruit is then cooked in a large pot along with sugar, pectin, and lemon juice. Pectin is a natural substance that helps the jam to set. The amount of pectin required depends on the type of fruit being used.
4. Skimming: As the fruit mixture cooks, it will produce foam or scum. This needs to be skimmed off regularly to ensure a smooth texture.
5. Testing for set point: Once the jam has cooked for a sufficient time, a spoonful is tested for its set point. To do this, a small amount of jam is placed on a cold plate and allowed to cool. If it is set and wrinkles when pushed with a finger, then the jam is ready.
6. Jar preparation: The jars and lids should be sterilized in boiling water and then dried. This ensures that the jam stays fresh and safe for consumption.
7. Filling and sealing: The hot jam is then poured into the sterilized jars, leaving about 1/4 inch of headspace. The jars are then sealed tightly with the sterilized lids.
8. Cooling: The jars are allowed to cool at room temperature, which helps to create a vacuum seal.
9. Labeling and storage: Once the jars are completely cool, they can be labeled with the date and type of jam. They can then be stored in a cool, dark place for up to a year.

The packing of jams is similar to that of jellies, where the jars are filled with the hot jam mixture and sealed with lids. The jars can then be labeled and stored in a cool, dark place. Some commercial jams are also packed in sachets or small plastic containers for easy and convenient use.

Packaging of jams is crucial to maintain their quality and shelf life. Here are some common packaging methods for jams:

1. Glass jars: Glass jars are a popular option for packing jams. They are non-reactive and do not affect the flavor or color of the jam. The jars should be sterilized before filling them with hot jam. The lids should also be sterilized and tightly sealed after filling.
2. Plastic containers: Plastic containers are a lightweight and convenient option for packing jams. They are available in different sizes and shapes. However, plastic containers may react with acidic foods and affect their flavor. It is recommended to use food-grade plastic containers for packing jams.
3. Metal cans: Metal cans are another option for packing jams. They provide a barrier to light and oxygen, which helps in preserving the quality of the jam. However, metal cans are not suitable for acidic foods as they may react with the metal and cause off-flavors.
4. Flexible pouches: Flexible pouches are becoming popular for packing jams. They are lightweight and convenient for storage and transportation. Flexible pouches are available in different sizes and shapes and can be custom printed with branding and nutritional information.

It is important to ensure that the packaging material is food-grade and suitable for the type of jam being packed. The packaging should be labeled with the name of the jam, ingredients, nutritional information, and any allergens. Proper labeling helps consumers make informed decisions and prevents any health issues.

Ketchup

Ketchup is a popular condiment made from tomatoes, vinegar, sugar, and various spices. Here is a step-by-step process for preparing ketchup:

1. Selecting the tomatoes: Choose ripe and firm tomatoes. Roma tomatoes are preferred for ketchup because they have less water content and more pulp.
2. Cleaning and chopping: Wash the tomatoes thoroughly and chop them into small pieces. Remove any stems or blemishes.
3. Boiling the tomatoes: Put the chopped tomatoes in a large pot and bring them to a boil. Reduce the heat and let the tomatoes simmer for about 30 minutes. Stir occasionally to prevent burning.
4. Straining the tomatoes: Once the tomatoes are soft and cooked, pass them through a strainer or a food mill to remove the seeds and skins. This will give you a smooth tomato puree.
5. Adding the other ingredients: Pour the tomato puree back into the pot and add vinegar, sugar, salt, and other spices such as onion powder, garlic powder, and paprika. Mix well and bring the mixture to a boil.
6. Simmering and reducing: Reduce the heat to low and let the ketchup simmer for about 1-2 hours until it thickens and reduces to a desired consistency. Stir occasionally.

7. Blending and straining: Once the ketchup has thickened, let it cool for a few minutes and then blend it with an immersion blender or a regular blender until smooth. Pass it through a strainer to remove any remaining solids.
8. Bottling and storing: Pour the ketchup into clean and sterilized bottles or jars. Seal them tightly and store them in a cool and dark place. Homemade ketchup can last up to 1 month in the refrigerator.

It is important to follow proper food safety measures when preparing and storing ketchup to prevent contamination and spoilage.

Ketchup can be packed in various containers such as glass bottles, plastic squeeze bottles, and sachets. The choice of packaging material depends on factors such as cost, convenience, and product shelf life.

Glass bottles are a popular choice for ketchup packaging as they are reusable and do not react with the acidic nature of the product. Plastic squeeze bottles are also commonly used as they are lightweight and unbreakable, making them ideal for outdoor events and picnics. Sachets are convenient for on-the-go consumption and are commonly used in fast-food restaurants.

Before packing, the ketchup is cooled and filtered to remove any impurities. It is then pumped into the packaging containers using a filling machine. The containers are sealed with an airtight cap or lid to prevent spoilage and contamination.

The packaging material may be labeled with information such as the ingredients, nutritional value, and manufacturing date. The label may also include branding and promotional messages to attract consumers.

Once the ketchup is packed, it is stored in a cool, dry place away from direct sunlight until it is ready to be distributed to retailers and consumers. Proper packaging and storage help to maintain the quality and freshness of the product, ensuring that it has a longer shelf life.

Chips

Chips, also known as crisps, are a popular snack made from sliced, fried or baked potatoes. The process of making chips involves several steps including selecting the right potatoes, slicing them into thin pieces, frying or baking them, and seasoning them.

A detailed explanation of the preparation process for chips:

1. Selection of Potatoes: The first step in preparing chips is selecting the right type of potatoes. Ideally, potatoes that are low in sugar and high in starch content should be used as they produce crispy chips. Popular varieties used for making chips include Russet, Yukon Gold, and Kennebec.
2. Washing and Peeling: The potatoes are washed thoroughly to remove any dirt or debris. They are then peeled using a potato peeler.
3. Slicing: The peeled potatoes are then sliced into thin, uniform pieces using a mandoline or a sharp knife. The thickness of the slices depends on personal preference, but they should be uniform to ensure even cooking.
4. Drying: The sliced potatoes are then placed on a clean kitchen towel or paper towels to dry out excess moisture. This is important to ensure that the chips become crispy when fried or baked.
5. Frying or Baking: The dried potato slices are then either fried in hot oil or baked in an oven until crispy and golden brown. For frying, a deep fryer or a heavy-bottomed pot is used with vegetable oil or other suitable frying oil. For baking, the potato slices are arranged in a single layer on a baking sheet and baked in a preheated oven until crispy.
6. Seasoning: Once the chips are cooked, they can be seasoned with salt or other seasonings such as garlic powder, paprika, or onion powder.
7. Packaging: The chips are then packaged in airtight bags or containers to keep them fresh and crispy. Nitrogen flushing is often used to remove oxygen and extend the shelf life of the chips.

The preparation of chips involves selecting the right type of potatoes, slicing them into thin pieces, drying, frying or baking them until crispy, seasoning, and packaging them in airtight bags or containers.

Packing of chips involves the use of various packaging materials to ensure that the chips are protected from contamination, moisture, and oxidation during storage and transportation. The most commonly used packaging materials for chips include plastic bags, aluminum foil bags, paper bags, and cans.

Plastic bags are the most common packaging material for chips. They are lightweight, easy to produce, and provide a good barrier against moisture and contamination. Plastic bags come in different sizes, shapes, and designs. The bags are usually printed with the brand name, product information, and nutritional facts.

Aluminum foil bags are another popular packaging material for chips. They offer a high level of protection against moisture, light, and oxygen. The bags are usually laminated with a layer of plastic film to provide a barrier against contamination. Aluminum foil bags are available in various sizes and shapes, and they can be printed with the brand name and product information.

Paper bags are an environmentally friendly alternative to plastic bags. They are made from renewable resources and are biodegradable. Paper bags are lightweight and can

be printed with the brand name, product information, and nutritional facts. However, they provide less protection against moisture and contamination compared to plastic and aluminum foil bags.

Cans are also used for packing chips. They are durable, provide excellent protection against moisture and light, and are stackable, making them easy to store and transport. Cans can be printed with the brand name, product information, and nutritional facts. However, they are more expensive than other packaging materials, and they are not as convenient for consumers to carry around.

The packing of chips involves the use of various packaging materials such as plastic bags, aluminum foil bags, paper bags, and cans. The packaging material chosen depends on factors such as cost, level of protection required, and environmental concerns. The packaging is usually printed with the brand name, product information, and nutritional facts to help consumers make informed choices.

MULTIPLE CHOICE QUESTIONS

1. Arrange the steps of making cucumber pickle in the proper sequence.
   (a) Washing and peeling.
   (b) Cut into small pieces and mix with salt.
   (c) Keep in sun for a week.
   (d) Add spices and vinegar.
   (e) Keep in a jar for 8 hours and remove excess water.

   Choose the correct answer from the options given below
   A. (d) → (a) → (b) → (e) → (c)
   B. (d) → (b) → (e) → (a) → (c)
   C. (d) → (e) → (b) → (a) → (c)
   D. (d) → (a) → (c) → (b) → (e)

2. Identify the incorrect concepts with respect to traditional storage method of fruits and vegetables?
   (a) Sand and coir storage
   (b) High altitude storage
   (c) Cold storage
   (d) Pit storage
   (e) Modified atmospheric storage

   Choose the correct answer from the options given below:
   A. (c) and (e) only
   B. (a) and (c) only
   C. (b) and (d) only
   D. (d) and (e) only

3. The extent of food processing percentage in India is approximately:
   A. 80%
   B. 20%
   C. 40%
   D. 2%

4. The methods of preservation of fruit juices include:
   (a) Carbonation
   (b) Flash pasteurization
   (c) Over flow method
   (d) Holding pasteurization
   (e) Fermentation

   Choose the correct answer from the options given below:
   A. (a), (b), (c) only
   B. (b), (c), (d) only
   C. (c), (e) only
   D. (a), (d) only

5. Addition of sugar at minimum is required to pressure any food product. This also improves the taste and calorific value of the preserved products.
   A. 50%
   B. 65%
   C. 60%
   D. 75%

6. Which one of the following variety belongs to Rose flower?
   A. Ruby red
   B. Gladiator
   C. Cracker jack
   D. Butter scotch

7. Gerbera is commercially propagated through:
   A. Suckers
   B. Cutting
   C. Budding
   D. Layering

8. While preparing pickles, preservation is primarily achieved through the addition of:
   A. Salt
   B. Colour
   C. Water
   D. Pectin powder

9. Keeping micro-organisms out from entering into the food is termed as:
   A. Spoilage
   B. Asepsis
   C. Decomposition
   D. Deterioration

10. Rose is commercially propagated by:
    A. Seed
    B. Layering
    C. Grafting
    D. Budding

11. Desuckering and mattocking is practiced in which crop?
    (a) Mango
    (b) Citrus
    (c) Banana
    (d) Sugarcane
    (e) Pomegranate

    Choose the correct answer from the options given below:
    A. (a) and (c) Only
    B. (b) and (e) Only
    C. (c) Only
    D. (c) and (d) only

12. Lychee (Litchi chinensis) is typically propagated by which method?
    A. Grafting
    B. Cutting
    C. Seed
    D. Marcotting or gootee

13. Which is the regular bearing variety of mango?
    A. Sindhu
    B. Neelam
    C. Dudhpedha
    D. Kesar

14. Which of the following statements are incorrect with reference to the objective of storage of vegetables and fruits?
    (a) Slow the biological activity and micro-organism growth
    (b) Avoid glut and distress sale in the market
    (c) Making the food available in on-season
    (d) Regulate the market in an orderly manner
    (e) Increasing ethylene production rate

    Choose the correct answer from the options given below:
    A. (c) and (e) only
    B. (c) and (d) only
    C. (a) and (b) only
    D. (a) and (e) only

15. Identify the correct statements about horticulture.
    (a) Fruits and vegetables yield large quantity of food per unit area as compared to cereals.
    (b) Horticulture crops are not remunerative
    (c) Fruits and vegetables are an important protective foods
    (d) Horticultural products are not the raw materials for many industries
    (e) Horticultural products are not contributing to national wealth

    Choose the correct answer from the options given below:
    A. (d) and (e) only
    B. (a) and (b) only
    C. (a) and (c) only
    D. (b) and (e) only

16. In the system of planting, row to row and plant to plant distance is the same.
    A. Triangular
    B. Rectangular
    C. Contour
    D. Square

17. Mangifera indica is the botanical name of which crop?
    A. Mango
    B. Guava
    C. Papaya
    D. Anola

18. Rutaceae is the family of which crop?
    A. Mango
    B. Orange
    C. Papaya
    D. Banana

19. The branch of horticulture that refers to the study of vegetables is known as:
    A. Pomology
    B. Floriculture
    C. Plantation
    D. Olericulture

20. Which technique aims at the development of a strong framework of the plant?
    A. Pruning
    B. Training
    C. Bahar Treatment
    D. Ringing

21. What is the system of planting followed only on hills with high slopes?
    A. Quincunx system
    B. Hexagonal system
    C. Rectangular system
    D. Contour system

22. Which family does Mandarin orange (Santra) belong to?
    A. Anacardiaceae
    B. Punicaceae
    C. Rutaceae
    D. Gramineae

23. In which crop is denavelling practice followed?
    A. Fig
    B. Orange
    C. Grape
    D. Banana

24. Which pigment is responsible for the red color of tomatoes?
    A. Capsanthin
    B. Lycopene
    C. Anthocyanin
    D. Melanin

25. Which of the following is not a health benefit of consuming fruits and vegetables regularly?
    A. Reduced risk of chronic diseases
    B. Improved digestion and bowel movements
    C. Enhanced immune system
    D. Increased risk of heart disease

26. Which nutrient is commonly found in green leafy vegetables?
    A. Vitamin C
    B. Calcium
    C. Vitamin B12
    D. Iron

27. What is the primary reason for including a variety of colorful fruits and vegetables in your diet?
    A. They provide a range of essential vitamins and minerals
    B. They enhance the flavor of meals
    C. They are low in calories
    D. They are easy to prepare and store

28. Which of the following is a root vegetable?
    A. Broccoli
    B. Carrot
    C. Spinach
    D. Tomato

29. Which vegetable is known for its high vitamin C content?
    A. Spinach
    B. Carrots
    C. Broccoli
    D. Bell peppers

30. Which of the following is an example of crop diversification?
    A. Growing the same crop on the same field every year
    B. Growing different crops on the same field in different seasons
    C. Growing the same crop on different fields in different seasons
    D. Growing only one type of crop on a farm

31. Which of the following is a benefit of crop diversification?
    A. Increased soil erosion
    B. Increased pesticide use
    C. Increased risk of disease and pests
    D. Reduced risk of crop failure

32. What is the primary goal of the processing industry in agriculture?
    A. To reduce the amount of crops produced
    B. To increase the amount of crops produced
    C. To make crops easier to transport and store
    D. To reduce the nutritional value of crops

33. Which of the following is an example of food processing?
    A. Canning vegetables
    B. Harvesting crops
    C. Irrigating fields
    D. Plowing fields

34. Which of the following is a challenge faced by the processing industry?
    A. Lack of demand for processed foods
    B. High costs of processing equipment
    C. Difficulty in transporting processed foods
    D. All of the above

35. What is the primary purpose of an orchard?
    A. To grow ornamental plants
    B. To grow vegetables
    C. To grow fruits
    D. To grow flowers

36. What is the ideal location for an orchard?
    A. Low-lying areas with poor drainage
    B. Areas with strong winds
    C. Areas with heavy rainfall
    D. Areas with well-drained soil and adequate sunlight

37. What is the purpose of a kitchen garden?
    A. To grow vegetables for commercial purposes
    B. To grow flowers for decoration
    C. To grow herbs and vegetables for household consumption
    D. To grow ornamental plants for display

38. Which of the following is a factor to consider when laying out an orchard?
    A. The availability of ornamental plants
    B. The amount of rainfall in the area
    C. The amount of sunlight in the area
    D. The availability of pesticides in the area

39. What is the purpose of ornamental gardening?
    A. To grow fruits for commercial purposes
    B. To grow flowers for decoration
    C. To grow herbs and vegetables for household consumption
    D. To grow ornamental plants for display

40. Which of the following is NOT a benefit of intercropping?
    A. Reduced pest and disease incidence
    B. Efficient use of land and other resources
    C. Increased soil fertility
    D. Decreased crop yields

41. What is the primary purpose of training and pruning in crop cultivation?
    A. To increase yield
    B. To control pests and diseases
    C. To reduce water usage
    D. To improve soil fertility

42. Which of the following is a common method of protection against frost?
    A. Mulching
    B. Irrigation
    C. Fertilization
    D. None of the above

43. What is the purpose of sunburn protection in crop cultivation?
    A. To increase yield
    B. To control pests and diseases
    C. To reduce water usage
    D. To prevent damage to plant tissues

44. Which of the following is NOT a planting system used in crop cultivation?
    A. Quincunx
    B. Rectangular
    C. Triangular
    D. Circular

45. Which of the following is not an example of a shrub?
    A. Hibiscus
    B. Rose
    C. Mango
    D. Camellia

46. What is the difference between an annual and a perennial plant?
    A. Annuals are grown in pots while perennials are grown in the ground.
    B. Annuals live for one growing season while perennials live for more than one season.
    C. Annuals have woody stems while perennials have herbaceous stems.
    D. Annuals are fruit-bearing while perennials are not.

47. Which of the following is not a method of plant propagation?
    A. Tissue culture
    B. Seed production
    C. Fermentation
    D. Grafting

48. What is the process of grafting?
    A. Joining two plants together to create a new plant.
    B. Separating a part of a plant to create a new plant.
    C. Cutting off the top of a plant to encourage new growth.
    D. Adding nutrients to the soil to improve plant growth.

49. Which of the following is not an example of a climber plant?
    A. Grapes
    B. Jasmine
    C. Bougainvillea
    D. Pansy

50. Which of the following fruits is a climacteric fruit?
A. Guava B. Citrus
C. Mango D. Papaya

51. Which of the following fruits requires a dry climate during ripening?
A. Banana B. Grapes
C. Mango D. Papaya

52. Which of the following fruits is a rich source of vitamin C?
A. Mango B. Papaya
C. Banana D. Citrus

53. Which of the following fruits requires ethylene treatment to induce ripening?
A. Grapes B. Citrus
C. Guava D. Banana

54. Which of the following fruits has the highest sugar content?
A. Mango B. Papaya
C. Banana D. Grapes

55. Which vegetable crop is considered as a good source of vitamin C?
A. Carrot B. Onion
C. Cabbage D. Tomato

56. Which of the following vegetable crops is not a root vegetable?
A. Radish B. Carrot
C. Onion D. Potato

57. Which vegetable crop is known for its high content of beta-carotene?
A. Cauliflower B. Spinach
C. Tomato D. Carrot

58. Which of the following vegetables is a good source of dietary fiber?
A. Radish B. Potato
C. Cabbage D. Spinach

59. Which vegetable crop is often used as a natural dye?
A. Radish B. Spinach
C. Onion D. Cabbage

60. Which of the following is a flower crop?
A. Mango B. Papaya
C. Marigold D. Guava

61. Which flower crop is commonly used for making garlands?
A. Gladiolus B. Canna
C. Chrysanthemums D. Roses

62. Which of the following vegetables is a root vegetable?
A. Tomato B. Onion
C. Cabbage D. Potato

63. Which vegetable crop is commonly used for making pickles?
A. Radish B. Carrot
C. Potato D. Onion

64. Which of the following is a leafy vegetable?
A. Radish B. Carrot
C. Spinach D. Cauliflower

65. Which method of fruit preservation involves heating the fruit in a sealed can or jar?
A. Dehydration B. Canning
C. Freezing D. Pickling

66. What is the process of removing air from packaging and sealing it to prevent spoilage?
A. Blanching
B. Canning
C. Vacuum packing
D. Fermentation

67. Which of the following is a chemical preservative commonly used in fruit preservation?
A. Salt B. Sugar
C. Vinegar D. Sulfur dioxide

68. What is the process of preserving food by exposing it to high pressure and temperature?
A. Dehydration B. Pasteurization
C. Irradiation D. Salting

69. Which method of vegetable preservation involves removing the water content through heat or air?
A. Canning B. Freezing
C. Dehydration D. Pickling

70. Which of the following is NOT a product prepared from fruits and vegetables?
A. Jellies B. Chips
C. Cheese D. Ketchup

71. Which preservation method involves removing water from the fruits and vegetables?
A. Canning
B. Pickling
C. Drying
D. Fermenting

72. Which of the following is NOT an ingredient used in preparing jams and jellies?
A. Sugar B. Pectin
C. Vinegar D. Fruit juice

73. Which of the following is a type of packaging used for preserving fruits and vegetables?
A. Aluminum foil
B. Plastic bags
C. Glass jars
D. All of the above

74. Which of the following is NOT a product made from potatoes?
A. Ketchup B. Chips
C. French fries D. Potato salad

ANSWERS

1	2	3	4	5	6	7	8	9	10
B	A	D	B	B	B	A	A	B	D
11	12	13	14	15	16	17	18	19	20
C	D	B	A	C	D	A	B	D	B
21	22	23	24	25	26	27	28	29	30
D	C	D	B	D	D	A	B	D	B
31	32	33	34	35	36	37	38	39	40
D	C	A	D	C	D	C	C	D	D
41	42	43	44	45	46	47	48	49	50
A	A	D	D	C	B	C	A	D	C
51	52	53	54	55	56	57	58	59	60
B	D	D	A	D	C	D	C	D	C
61	62	63	64	65	66	67	68	69	70
D	D	D	C	B	C	D	B	C	C
71	72	73	74						
C	C	D	A						