**E- PRACTICAL MANUAL**

**TEMPERATE FRUITS**

**HFS 211**

 **2(1+1)**

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**B.Sc. (Hons.) Horticulture**

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**Practical Manual on**

**Temperate Fruits**

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**Syllabus – HFS -211**

**Temperate Fruits**

**Credit Hours: 2(1+1)**

**Practical**

 Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies.

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Temperate Fruits (HFS 211) is a compulsory course offered to the students of B.Sc. (Hons.) Horticulture, which includes the varietal description, training and pruning and cultivation of various temperate fruit crops such as apple, pear, peach etc. For proper understanding of basic practices of Temperate Fruits, it is imperative not only to grasp the essentials through critical reading but also to meticulously and methodically conduct the practical exercises. As the Temperate Fruits have tremendous potential in Horticulture courses, exposure of under graduate students to the subject is essential under the present scenario. It has been long felt to develop a manual covering all the practical aspects of the above mentioned course which will be very useful for the UG students to understand the various field activities such as nursery bed preparation, fertilizer and manures application methods etc.

In developing the material for this manual, authors have relied upon the literature from several sources which is highly acknowledged. Some of the help came from discussion, field visit and various other sources. The author extends her gratitude to Dr. (Prof.) Narendra Pratap Singh Hon’ble Vice Chancellor, Dr. A.C.Mishra Director of Research Banda University of Agriculture & Technology Banda, Dr. A.K. Shrivastva Director PMEC, Dr. Satya Vrat Dwivedi Dean CoH for their encouragement to write this manual. The author also would like to thank Dr. Bijender Kumar Singh Assistant Professor, Dr. Om Prakash, Assistant Professor, Department of Fruit Science, who have helped in preparation of this manual. I hope that the manual will meet the requirement of undergraduate students studying Fruit Science.

Dated: January, 2024 **Dr. Nidhika Thakur**

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**Exercise- 1**

**Objective: Classification of temperate fruit crops**

**Introduction:** Temperate fruit plants are specific in the climatic requirement. They can tolerate both diurnal and seasonal wide fluctuation of temperature and are grown only in place where winter is distinctly cold. They require exposure of specific chilling temperature for certain period to break bud dormancy and initiate bud break. These fruit plants are generally deciduous and suitable of higher elevation as they can withstand frost.

Examples are: apple, pear, plum, apricot, almond, peach, strawberry, walnut, pecan nut and cherry.

[**Classification**](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=96151)**of temperate fruits:** [Classification](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=96151) is a system of placing an individual or a number in various groups, or to categorize them according to a particular plan or sequence which is in conformity with the nomenclature.

**Classification on the basis of plant stature**:

**Temperate tree fruits:** Fruits borne on the trees growing in the temperate climates such as apple, pear, stone fruits etc.

**Temperate small fruits:** Fruits generally borne on the vines, brambles or herbaceous plants grown under temperate climate like strawberry, crane berry, blackberry, blueberry etc.

**Temperate nuts**: Nuts are characterized by the hard shell outside, separating the kernel and husk of the fruit. Pecan nut, hazel nut and walnut are good examples of temperate fruit plants producing nuts.

**Classification based on fruit morphology:**

Depending on number of ovaries involved in fruit formation, fruits are classified into three groups.

**Simple fruits:** Simple fruits are derived from a single ovary of one flower. Simple fruits are further classified as fleshy and dry fruits.

**Fleshy fruits:** These are this fruits whose pericarp (ovary wall) becomes fleshy or succulent at maturity. The temperate fleshy fruits may be either pome or drupe.

**Pome:** The pome is an inferior, two or more celled fleshy, syncarpous fruit surrounded by the thalamus. The fruit is referred as false fruit as the edible fleshy part is not derived from the ovarian tissues but from external ovarian tissue thalamus. Examples of temperate pome fruits are apple, pear and quince).

**Fleshy fruit :** Pome (leathery carples, edible portion is receptacles)

Drupe (stone): This type of fruit derived from a single carpel, however, the olive is an exception in that the flower has two carples and four ovules but one carpel develop. Two ovules are borne in most of drupes but one seed develops. In this type of fruit, the pericarp is differentiated into three distinct layers; thin exocarp or peel of the fruits, the mesocarp which is fleshy and hard and stony endocarp, enclosing seed. Examples of temperate drupe fruits are cherry, peach, plum and apricot. In almond at maturity exocarp and mesocarp get separated as leathery involucres and are removed before marketing, only endocarp containing the edible seed is used hence it is nut.

**Fleshy fruit**: Drupes (one seeded, seed within stony endocarp)

**Dry fruits**: This type of fruit has been classified on the basis of pericarp (ovary wall) at maturity. The entire pericarp becomes dry and often brittle or hard at maturity.  They are dehiscent ( in which the seeds are dispersed from fruit at maturity) and indehiscent ( not split open when ripe) Nuts are typical example of indehiscent dry fruits

**Nut**: A fruit in which carpel wall is hard or bony in texture. Fruit is derived from a hypogynous flower (filbert) or an epigenous one (walnut) and is enclosed in dry involucres (husk). It is only one seeded, but in most cases in derived from two carpels. Examples are walnut, almond, [chestnut](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=96226), hazelnut and pecan nut. Dry fruits are not juicy or succulent when mature and ripe. When dry, they may split open and discharge their seeds (called dehiscent fruits) or retain their seeds (called indehiscent fruits).

**Achene:**  A one seeded fruit in which the seed is attached to ovary wall at one point. Example is strawberry.

**Aggregate fruits:** Aggregate fruits develop from numerous ovaries of the same flower. Individual ovary may be drupe or berry. Raspberry is included in this category.

**Multiple (composite) fruits:** Multiple or composite fruits are produced from the ripened ovaries of several flowers crowded on the same inflorescence. The example of this type is mulberry.

**Classification based on bearing habit:**

The flower bud is either terminal or lateral. Based upon the location of fruit buds and type of flower bearing structure to which they give rise, the temperate fruits are classified as under.

**Terminal bearer**:  Flower buds mixed, flowering shoot with terminal inflorescences. Examples are apple, pear, walnut (pistillate flowers) and pecan (pistillate flowers)

**Lateral bearer:** Flower bud containing flower parts only e.g. peach, apricot, plum, cherry, almond, walnut (staminate catkin) and pecan (staminate catkin)**.** Flower buds mixed, flowering shoots with terminal inflorescences e.g. blackberry, raspberry, blueberry, apple and pear (occasionally). Flower buds mixed, flowering shoot with lateral inflorescences e.g. persimmon, [chestnut](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=96226), pistachio nut, cranberry.

**Classification based on Fruit Growth Pattern:**

**Sigmoid pattern**:  The combined growth of fruit results from cell division, cell enlargement and air space formation results in sigmoid ( S- shaped) curve when fruit weight is plotted as function of time. Examples are apple, walnut, pecan, strawberry and pear

**Double sigmoid:** The first slow growth period coincides with the period of pit hardening, during which lignifications of the endocarp (stone) proceeds rapidly, while mesocarp and seed growth suppressed. Near the end of pit hardening, flesh cells enlarge rapidly until fruit is ripe, after which growth slows down and ceases. Examples are peach, plum, cherry and kiwifruit

**Botanical Classification of temperate fruit crops:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Family** | **Common Name** | **Scientific Name** | **Chromosome number (2n )** | **Origin** | **Fruit type** |
|  |  |  |  |  |  |
| Actinidiaceae | Kiwi | *Actinidia deliciosa* | 58 | Central America | Berry |
| Anacardiaceae | Hog plum | *Spondias cytherea* | - | - | Drupe |
| Indian hog plum | *Spondias pinnata* | - | - | Drupe |
| Pistachio nut | *Pistachia vera* | 30 | Iran/Iraq | Nut |
| Corylaceae/ Betulaceae | Filbert/ Hazelnut | *Corylus avellana* | - | - | Nut |
| Ebenaceae | American persimmon | *Diospyros vixgiana* | - | China | Berry |
| Persimmon | *Diospyros kaki* | 90 (6x) | China | Berry |
| Fagaceae | Chinese chest nut | *Chestua mollissima* | - | - | Nut |
| European/ sweet chest nut | *Chestua sativa* | - | - | Nut |
| Flacourtiacae | Governor’splum | *Flacourtia indica* | - | - | Berry |
| Rosaceae | Almond | *Prunus communis* | 16 | Central Asia | Drupe |
| Apple | *Malus x domestica* | 34 | South Western Asia | Pome |
| Apricot | *Prunus armeniaca* | 16 | North Eastern China | Drupe |
| Peach | *Prunus persica*  | 16 | China | Drupe |
| Pear | *Pyrus communis* | 34 | Western China | Pome |
| Plum | *Prunus domestica* | 32 | China | Drupe |
| Sour cherry | *Prunus cerasus* | 16 | South East Europe | Drupe |
| Sweet cherry | *Prunus avium* | 16 | Asia Minor | Drupe |
| Strawberry | *Fragaria vesca* | 56 (8x) | France | Etaerio of drupes |
| Juglandaceae | Walnut | *Juglans regia* | 32 | Central Asia | Nut |
| Peacan nut | *Carya illinoensis* | 32 | North America | Nut |

**Exercise – 2**

**Objective: Nursery management practices in fruit crops**

Nursery is a place where seedling, saplings or any other planting materials are raised, propagated, multiplied and sold out for planting. The prerequisite of a successful and remunerative fruit production is the availability of good quality, true to type and diverse plant materials. Setting up of a nursery is a long term venture and requires careful planning and expertise.

**Importance of Nursery:**

1. The young seedlings require special attention during the first few weeks after germination. It is easier and economical to look after the young and tender seedlings growing in nursery bed in a small area than in a large permanent site.

2. Majority of fruit crops are propagated by vegetative means. The propagules require special skill and aftercare before transferring them in the main field. In a controlled condition in nursery all these can be provided successfully by skilled labour.

3. Cuttings are best rooted and grafts are hardened in the mist house chamber which is an integrated part of a nursery.

4. Direct sowing method is not so successful in several crops when compared with transplanting of seedlings raised in nursery.

5. Plants hardened in the nursery are preferred for causality replacement in orchards.

6. Besides these, raising of seedlings or saplings in nursery provides more time for pre-planting operations/preparations.

7. Seasoning/hardening of seedlings against natural odds is only possible in nursery.

**Establishment of nursery**

To be a viable venture, the nursery should be established in such an area where cultivation of fruit crops is on sizeable area and there is need for a nursery, having demand for saplings. In such area/region, following considerations need to be observed for selecting an appropriate location.

1. Nursery should be established at central place.

2. Nursery soil should be deep, fertile, well drained and free from pathogens.

3. It should be well connected with roads/transport media.

4. The area should be well protected.

5. Soil and micro-climatic conditions should be appropriate.

6. Availability of irrigation and power supply should be ensured.

7. Availability of skilled persons should be ensured.

8. Availability of mother stock and root stocks should be ascertained.

**Components of modern nursery**

A number of structures may be necessary for raising a nursery. To begin with, the following structures need to be constructed:

**1. Fencing:**

Proper fencing should be done to protect a nursery particularly from stray animals. For a model of 0.5 acre area, an amount of Rs.30000 has been considered as the total cost for erecting a fencing around the boundary.

**2. Progeny block (bud wood source tree)**

In progeny block, true to type mother plant are maintained in the nursery. Suitable plant types with existing superior cultivars/varieties should be collected and maintained in the progeny block. The mother plants should be true to type, healthy, heavy bearer with standard quality fruit

having tolerance to biotic and abiotic stresses. Care should be taken to label the plants properly. The bud wood source trees are maintained by adopting appropriate sanitary procedures. One is to

know the diseases, which are to be taken care of. Some diseases are only transmissible by graft and caused by virus, some by contaminated pruning tools, some transmissible by seeds. In addition, infectious diseases may be caused by surface pathogens, which are not graft transmissible but may contaminate nurseries and inflict severe economic losses.

**3. Rootstocks and seed gardens**

After establishment of scion bank, next priority should be given for the establishment of the rootstocks. Seed propagation is the most usual way for mass production of rootstocks. There should be seed gardens comprising of the seed source trees to produce rootstock seeds. While establishing seed gardens, the rootstocks should be planted into separate blocks with windbreak and shelter belts to avoid cross-pollination and keep plant trueness to type. The plant to plant spacing for seed gardens should be kept close. The basic information should be taken into account for planning of seed gardens, which must be properly maintained to avoid diseases caused by phytophthora, nematode, bacteria and virus.

**4. Growing structures:**

There should be provision of modern propagation structure like greenhouse/polyhouse, mist chamber etc. These structure provide optimum growing conditions for seed germination, rooting of cutting, hardening of seedlings. Now a days green house has become a prerequisite of Hi-Tech nursery. The greenhouse helps in providing additional carbon dioxide to the plants to enhance their rate of photosynthesis. Shade nets are useful not only for reducing heat injury to young plants, but their use also reduces transpiration.

**5. High Humidity Chamber:**

This technique resolves the common problem of grafts or cuttings dying due to desiccation (drying up) when planted in the soil for rooting, by ensuring a humid atmosphere around the cuttings, thus preventing excessive evaporation.

**6. Use of Supplementary Light**

Several plants go into winter dormancy when the day length gets short. Additional light from tube lights, given after sunset, creates long day condition that prevents the plants from going into winter dormancy. Light, given at the end of the day (photo-period), also encourages growth of green leaves, they grow tall without developing lateral branches. Exposure to light is necessary only for about half an hour immediately after the end of the photo-period to get the desired results. Scientific use of supplementary light substantially enhances the growth of plants.

**7. Drought Hardening**

Plants that are raised under high atmospheric humidity and shade, often die due to transplanting shock when shifted to the fields. To prevent this, the plants are hardened by allowing external dry air to enter the chamber gradually. This is achieved by lifting the plastic film on two opposite sides of the high humidity chamber to some extent to create small openings in the chamber. The openings are widened every day, in such a way that the entire film can be removed after about 8 days. In this way, the plants get adapted to dry air gradually. Such plants can be transplanted in the fields but as precautionary measure it is advisable to transplant on a rainy or cloudy day.

**Management of nursery:**

Nursery plants require due care and attention after having either emerged from the seeds or have been raised from other sources like rootstock or through tissue culture technique. Generally they are grown in the open field under the protection of mother nature where, they should be able to face the local environment. It is the duty & main objective of a commercial nursery grower to supply the nursery plants with suitable conditions necessary for their development & growth. This is the major work of management in the nursery which includes all such operations right from the emergence of young plantlet till they are fully grown up or are ready for uprooting & transplanting in the main field.

1. **Potting of seedling:**

Before planting of sapling in the pots, the pots should be filled up with proper potting mixture. Now a days different size of earthen pots or plastic containers are used for propagation. For filling of pots loamy soil, sand and compost can be used in 1:1:1 proportion. Sprouted cuttings, bulbs, corms or polythene bag grown plants can be transferred in earthen pots for further growth. All the necessary precautions are taken before filling the pots and planting of sapling in it.

1. **Manuring and irrigation:**

Generally sufficient quantity of nutrients is not available in the soil used for seedbed. Hence, well rotten FYM / compost and leaf mould is added to the soil. Rooted cuttings, layers or grafted plants till they are transferred to the permanent location, require fertilizers. Addition of fertilizers will give healthy and vigorous plants with good root and shoot system. It is recommended that each nursery bed of 10 x 10 m area should be given 300 gm of ammonium sulphate, 500 gm of single super phosphate and 100 gm of muriate of potash. Irrigation either in the nursery beds or watering the pots is an important operation. For potted plants hand watering is done and for beds low pressure irrigation by hose pipe is usually given. Heavy irrigation should be avoided.

1. **Plant protection measures:**

Adoption of plant protection measures, well in advance and in a planned manner is necessary for the efficient raising of nursery plants. For better protection from pest and diseases, regular observation is essential. Disease control in seedbed: The major disease of nursery stage plant is **“damping off”.** For its control good sanitation conditions are necessary. Preventive measures like treatment with 50% ethyl alcohol, 0.2% calcium hypochloride and 0.01% mercury chloride is done. These treatments are given for 5 to 30 minutes. Some of the seed treatment are as follows:

 **i) Disinfection:** The infection within the seed is eliminated by use of formaldehyde, hot water or mercuric chloride.

**ii) Hot water treatment of seeds:** Dry seeds are placed in hot water having a temperature of 48°C – 55°C for 10-30 minutes.

**iii) Protection of seeds:** In dry seed treatment organo mercuric and non-mercuric compounds like agallal, aretan –6, and tafasan-6. For this the seeds are shaken within the seed container. While in wet method, the seeds are immersed for certain period in liquid suspension.

**iv) Soil treatment**: Soil contain harmful fungi, bacteria, nematodes and even weeds seeds, which affect the growth and further development of plant. These can be eliminated by heat and chemical treatment. For that soil is disinfected by heating to the temperature of about 60°C for 30 minutes.

**v) Chemical treatment**: The chemicals like formaldehyde, methyl bromide, chloropicrin, vapam are used. Other diseases like rust, powdery mildew, leaf spot, bacterial blight, yellow vein mosaic are also observed. For control of these diseases Bordeaux Mixture, Carbendazime, Redomil can be used.

**4. Weed control:** Weeds compete with plants for food, space and other essentials. So timely control of weeds is necessary. For weed control weeding, use of cover crops, mulching, use of chemicals (weedicides) are practiced. Pre-emergence weedicides like Basaline or post-emergence weedicide like 2,4-D and Roundup are useful.

**5. Measures against heat and cold:** The younger seedling is susceptible to strong sun and low temperature. For protection from strong sun, shading with the help of timber framework of 1 meter height may be used. Net house and green house structures can also be used.

**6. Packaging of nursery plants:** Packing is the method or way in which the young plants are tied or kept together till they are transplanted. So they have to be packed in such a way that they do not lose their turgidity and are able to establish themselves on the new site. At the same time, good packing ensures their success on transplanting. For packing baskets, wooden boxes, plastic bags are used. In some parts of the country banana leaves are also used for packing the plants with their earth ball. This is useful for local transportation.

**7. Sale Management:** In general the main demand for nursery plants is during rainy season. A proper strategy should be followed for sale of nursery plants. For that advertisement in local daily newspapers, posters, hand bills, catalogue and appointment of commission agents can be followed.

**8. Management of mother plants**: Care of mother plants is necessary so as to get good quality propagules and scion. It includes: 1. Labeling and records 2. Certification 3. Irrigation 4. Fertilization 5. Pruning 6. Protection from pests and diseases 7. Collection and development of new mother plants.

**Exercise - 3**

**Objective: Identification and description of varieties of apple and pear**

**Apple**

**Red Delicious**: Originated as chance seedling in the orchards of Josse Hiatt near Paru in USA Hiatt. In 1894) Later named as Red Delicious by Stark Brothers Nurseries. Fruit large sized and oblong conical in shape. Ground colour is greenish-yellow with red streaks. The colour of flesh is creamish. Fruit ripens in third week of August.

**Starking Delicious:** Also known as Royal Delicious, is a Limb Sport of Red Delicious in Monsoville, New Jersey, USA (1921) Tree moderately vigorous, fruit large, conical in shape with prominent calyx lobes, skin colour yellow with red stripes all over the surface, flesh firm, sweet, juicy. Fruit mature earlier than Red Delicious and ready to picking in 130-140 days from full bloom.

**Rich-a-Red:** In 1919 Rich-a-red was discovered as a whole tree mutation in the orchard of LJ Richardson, Monitor Washington, USA. Fruits are large sized and oblong conical . Ground colour greenish yellow with red wash all over, Lenticels are conspicuous.

**Top Red Delicious:** A bud mutation of Short Well Delicious. Standard type. Fruits conical with predominant lobes. Fruits large, medium with dark red streaks over yellow back ground. Flesh yellowish cream sweet, aromatic and juicy, matures 10-15 days earlier than the Starking (Royal) Delicious

**Red Chief:** Bud sport of Starkrimson. Tree size small, compact and forms number of spurs, very productive and regular in bearing. Fruit medium to large, conical in shape with prominent calyx lobes. Fruit colour dark red with prominent stripes. Colour development 10-15 days earlier than Starking Delicious. Flesh creamy, crisp and juicy.

**Vance Delicious:** A limb sport of Delicious. Standard type. Fruits medium to large, conical with prominent lobes with dark red stripes over yellow background. Better and early colour and gives higher yield than Royal Delicious. Flesh is yellowish cream sweet and juicy, matures 15-20 days earlier than Starking Delicious

**Hardeman**: A whole tree mutation of Delicious. Standard type and vigorous. Fruits medium to large, conical with prominent lobes. Dark red stripes over yellow background. Matures at the same time of Starking Delicious

**Skyline Supreme Delicious:** A whole tree mutation of Starking Delicious. Standard type. Fruits medium to large, conical in shape with five prominent lobes and surface colour is red wash. Fruits develop early and better colour and matures 10-15 days earlier

**Bright-N-Early**: It is a semi spur types strain of Red Delicious a limb sport. Fruits are conical in shape with deep bright red stripes. Fruit flesh light cream sweet and juicy. Fruits mature 7-10 early early Starking Delicious.

**Real Mecoy Red Delicious:** A mutation of Red Delicious. Standard type. Fruits are conical with prominent lobes. The fruit colour is red wash over yellow background. Fruit matures 10 days early than Starking Delicious, sweet and juicy.

**Well Spur**: A whole tree variation of Starking Delicious. Spur type variety and fruits are more conical with deep red wash, covering whole surface. Five lobes are prominent. Fruits mature 15-20 days early than Starking Delicious. Flesh is yellowish cream, sweet and juicy.

**Silver Spur:** A whole tree variation of Hi Early Red. A spur type cultivar and fruits are conical with deep red submerging streaks. Fruits mature 15 days early than Starking Delicious.

**Starkrimson Delicious**: A whole tree mutation of Starking Delicious. Fruits are more conical with prominent lobes with scarlet red wash, covering whole surface. Flesh is yellowish cream, sub-acidic and juicy. Spur type. At higher elevations fruit size remain small and over coloured (black). This cultivar is suitable for lower and valley areas in the state.

**Red Spur**: A whole tree mutation of Starking Delicious. Tree growth spur type. Fruits are conical in shape with prominent lobes at calyx and deep red wash with conspicuous dots (lenticels) over whole surface and resemble Rich-a-red. Flesh yellowish cream, sub acidic and juicy, regular and prolific bearer. Fruit matures 10-15 days earlier.

**Criterion:** A hybrid between Golden Delicious and Starking Delicious and was found to be superior to Golden Delicious. The shape resembles to Starking Delicious and colour is golden yellow with red cheeks. The tree is standard type

**Mutsu** This cultivar is originated in Aomori by the Aomori Apple Experimental Station, Japan from the cross between Golden Delicious and Indo. This cultivar was selected in 1939. This cultivar was registered and introduced commercially in 1949. Heavy producer and moderately biennial bearer. Fruit is medium to large, round to oval in shape and resembles to that of Golden Delicious. Fruits are green which becomes yellow later on. Skin is thin. The flesh is yellowish white fine and juicy. Granny Smith Trees vigorous upright and spreading. Fruits are medium to large in size. Ground colour of fruit is green, turns greenish yellow at maturity. Lenticels are conspicuous, skin is smooth. The shape is round conical. Flesh is greenish white, firm juicy, good of blend of sugar/ acidity. A very late variety, good pollinizer and regular bearer.

**Black Ben Davis**: Popularly known as Kalidevi is Kullu Valley of Himachal Pradesh. The trees are very vigorous and fruits are medium to large in size. The fruits are round conical little flattened. The colour is striped dark red. Flesh is creamish white, firm juicy, aromatic sweet and mildly acidic.

**Golden Delicious:** It is partly self fruitfull. A chance seedling, heavy bearor and used as pollinizer variety. Fruit round to conical oblong, greenish yellow which turn golden yellow at ripening. Late maturing variety, takes 150-160 days from full bloom to harvest.

**Red Gold:** A pollinizer variety for Red Delicious and its sports. The fruits are small to medium size of dark, dull red colour. The fresh is white, sub acidic and juicy. It is a heavy and regular bearer but tends to develop biennial bearing habit if allowed to over-crop. It suffers from a mosaic virus which tends to restrict fruit size. After the initial years of cropping the free produces very small sized fruit.

**Tydeman’s Early Worcester**: A pollinizer for Delicious and its sports. (McIntosh and Worcester Pearmain) and was evolved at East Malling Research Station in 1929. The tree is vigorous and spreading. It is difficult to train because it has few laterals. The fruit is medium sized, greenish yellow covered with bright red colour. The flesh is white, juicy, fairly firm with a pleasant flavour. It matures early in 80-90 days from full bloom to maturity.

 **Manchurian**: It has compact, upright growth and bears six medium sized cupped white flowers per cluster and attracts good bee activity. Tip bloom continues throughout most of the bloom period and also has good return bloom

**Red Flesh**: This variety tends to be more leggy in its growth habit unlike Manchurian, which is compact and upright. The flowers are off red colour and because of this bee activity is poor. It is also highly susceptible to powdery mildew

**Snow Drift:** A very profuse bloomer on first or second year wood having five small to medium sized, cupped, white flowers per cluster. If not trained, it attains bushy oval shape, leaves are small and glossy.

**Golden Hornet:** It has drawn attention for strong pollen viability and a longer period of dehiscence. Flowering is alternate or biennial on spurs. This tendency, however, can be checked by post blooming pruning. It has 5-6 medium sized cupped white flowers per cluster.

**Pear**

**Bartlett:** It is known as William Bartlett. This variety originated in England. Tree large, prolific and regular bearer. Fruit medium to large, ovate pyriform, green when picked, which turns bright yellow on ripening.

**Max Red Bartlett:** Bud mutant of Bartlett. Tree and fruit character resemble with parent except that fruit colour is dark cranberry red.

**Red Bartlett:** Fruit medium to large in size, obovate – acute- pyriform, greenish with red blush on one side, flesh white with fine melting texture, crisp, juicy, ripen from end of June to mid July

**Starkrimson:** It originated in Michigan, USA as an all-over red bud sport. Tree large and heavy bearer. Fruit large, colour rich crimson all over the fruit, flesh white. It is early maturing variety and matures 10-15 days before Bartlett.

**Other cultivars of pear are as listed below:**

**Cultivars High hills:** Flemish Beauty, Conference and Clapp's Favourite

**Mid, Low hills and Valley areas:** Patharnakh, Kieffer, William, Lagoon, Fertility, Baggugosha, Punjab Beauty and Punjab Gold

**Exercise - 4**

**Objective: Identification and description of varieties of stone fruits**

**Peach:**

**July Elberta:** This is most important and commercially grown variety in mid hills. Fruit medium to large, skin smooth, pale yellow with red splash. Flesh firm, yellow, juicy, sweet in taste, freestone. This is good for canning.

**Redhaven:** A cross of Halehaven and Kalhaven. Fruit medium in size, round, suture prominent, skin yellow overlaid re to deep red clour, attractive, pubescence light to medium, flesh yellow red at pit, very firm, freestone, early maturing.

**Shan-e-Punjab:** This is one of lading low chill variety and grown commercially in sub- tropical climate. Fruit matures in the first week of May. Tree vigorous and prolific bearer. Fruit yellow in colour with red blush. Flesh yellow, freestone, juicy and sweet.

 **Prabhat:** This is another important low chill variety. Tree medium and very heavy yielder. Fruit colour yellow with red blush. Flesh yellow with red coloration, firm and slightly acidic.

**Snow Queen (Nectarine):** Tree heavy bearer. Fruit medium in size, skin colour white with shinning red overcolour, smooth without fuzz. Flesh white, good flavor, clingstone.

**May Fire:** Fruit medium, smooth, skin colour green to white with deep red over colour. Flesh white, attractive, juicy, clingstone and sweet. Fruit matures very early in mid May.

**Plum:**

**Santa Rosa:** Tree upright, vigorous and very productive. Fruit large, heart shape, purplish crimson in colour. Flesh amber in colour with red near the skin. Fruit juicy and flavored. It is self fruitful variety.

**Fronteir:** Tree semi-vigrous, upright in growth and productive. Fruit large, skin purplish red, fruit heart shape, Flesh deep red, very sweet, juicy, firm and freestone. Fruit matures 10-15 days after Santa Rosa.

**Mariposa:** An upright growing tree. Fruit heart shape with greenish yellow skin mottled with red. Flesh red in colour, juicy and firm. Late maturing variety

Some other commercial cultivars of plum are Satluj Purple, Satsuma, Kala Amritsari and Doris

**Apricot:**

**Royal:** The fruit is large in size, yellow with red spot, flesh yellow, juicy, and sweet. Kernel sweet, late maturing variety, good for dessert and canning.

**New Castle Apricot:** Early maturing variety. Fruit round, medium sized and barium red yellow. The flesh is sweet and juicy, mature in May and suitable for warmer areas.

**Moorpark:** Self-fruitful, this large apricot was developed in the eighteenth century. Considered one of the best. Juicy and aromatic; sweet rich, plum like taste. Brownish-red skin with specks and dots; yellow to orange flesh. Mid season harvest.

**Cherry:**

**Black Heart:** Tree is upright. Fruit large size and heart shape. Colour of fruit dark red.

 **Stella:** Tree vigorous and spreading, heavy bearer, self incompatible variety. Fruit large to medium, black in colour, heart shaped to oval.

**Exercise – 5**

**Objective: Identification and description of varieties of strawberry, persimmon and kiwifruit**

**Strawberry:**

**Chandler:** Chandler variety was originally developed in California. The vigorous, high-yielding, June bearing Chandler strawberry plants produce very desirable strawberries. Fruit is very large, firm, and produce early-season to mid-season. The strawberries vary from being long and wedge-shaped to large and conical. They are a brilliant red color, glossy, and have an exceptional flavor profile.

 **Camarosa:** Camarosa is typical of short-day types. Plants are larger, more erect, and more vigorous than plants of `Chandler`, and are generally similar in form to plants of Oso Grande. Camarosa are larger, somewhat longer and more narrow than for ` The fruit shape for Camarosa is very flat conic, and is easily distinguished from Chandler (flat conic, with some long conic) and Oso Grande (rounded or blocky conic). Achenes vary from light red to dark red.

**Sweet Charlie:** Sweet Charlie was developed at the University of Florida’s Gulf Coast Research and Education Center in Hillsborough County, Florida. After The Sweet Charlie cultivar was hand pollinated as a cross between FL 80-456 and Pajaro. Sweet Charlie strawberry plants are small and compact making picking relatively easy. The Sweet Charlie strawberries are medium in size, deliciously sweet. Sweet Charlie is June bearers, but an excellent short-day variety in warmer climates. They produce about a week before chandler and have a relatively low acid level Sweet Charlie is a vigorous plant. Fruits are firm, can tolerate gentle shipping over short distances, and have deep red mature strawberries.

**Persimon:**

**Hachiya:** It is an astringent variety with oblong pointed fruits. The fruits are of very high quality and bearing is fairly good.

**Fuyu:** It is a non-astringent variety with tomato shaped fruits. This is a raw eating type and the fruits can be eaten hard.

**Hyakume:** Fruits, roundish oblong to oblate, large, skin buff yellow to orange, flesh dark, crimson, firm, good quality.

**Kiwifruit:**

**Hayward:** Selected as a chance seedling by Hayward Wright This is most popular variety throughout the kiwifruit growing regions of the world because fruits have large size and more keeping quality. Length and breadth ratio is about 1.3:1, oval in shape and fruit weight ranges from 80-120g/fruit. It bears late than other cultivars and bear solitary flowers on fruiting canes. This is comparatively shy bearer and has a tendency towards biennial bearing. This variety require more chilling hours and can be grown at slightly higher elevation

 **Allison:** This is most popular varieties in India as it gives higher production. It resemble very much to cultivar Abbott, except that its fruits are slightly broader in proportion to the length. Length in to breadth ratio is about 1.6:1 and Fruit weight ranges from 40-90g/fruit. It is an early flowering and maturing, heavy and regular bearing variety.

**Abbott:** This is an early flowering and maturing varieties. Fruit medium size, Oblong and covered with dense hairs. Very sweet in taste with lower ascorbic content, heavy yielder and regular in bearing.

**Monty:** This is a good variety for lower elevation, prolific bearer late maturing variety. Fruits are oblong and resemble with those of Abbott and Allison, but somewhat wider towards the blossom end.

**Bruno:** Fruits are largest among the cultivars and slightly tapering towards stem end. Fruit length and breadth ratio is about 1.9:1 and fruit weight ranges from 40-70g/fruit. Fruits are very rich in ascorbic acid . Early flowering and maturity variety, heavy yielder and suitable for lower hills and valley areas. Allison Male - It flowers earlier than Tomuri and is a best pollinizer for cvs. Allison, Bruno, Monty and Abbott, regular with profuse flowering.

 **Tomuri:** It is late flowering and it appears usually in groups of 5 (1-7). It is a good pollinizer for cultivars Hayward.

**Exercise - 6**

**Identification and description of varieties of walnut and pecanut**

**Walnut:**

**Hartley:** This was selected from seedling by John Hartley. The colour of kernel is light, heavy yielder, tolerant to codling moth and blight. The shell is light colour, thin and filling good.

**Serr:** Trees very vigorous. It is lateral bearing variety. The kernel percentage is 59 of nut, light in colour.

**Chandler:** It is lateral bearing variety. Trees are moderate in vigour and sem-upright. The nut is large, oval, smooth with good seal and bright colour. Kernel percentage is 49

**Pecanut:**

**Western Schley:** This variety originated as a cross between Seedling and Taxas. Nut size medium, pointed both ends. High kernel percent (54-59) and good kernel quality.

**Burkett:** Good variety, plants are vigorous. Nut small to medium size, high kernel percentage (57 %).

**Mahan:** This variety introduced by F A Mahan. The tree is vigorous, precocious, prolific bearer with good foliage. The leaves fall late in the season. The nuts are extra large, thin shelled and tend to poor filling on older trees. It has given highest yield among various cultivars in India.

**Nellis:** A regular bearing variety with oblong, cylindrical nut tapering towards the end, shell light brown and has stripes at the base. Amber colored kernel constitutes 49.4% of nut, moderately filled and easily separated.

**Cheyenne:** This is a cross of Clark x Obom and released from Brownwood. Tree is very precocious, very productive, and pruning can control scab resistant and being recommended for highdensity purpose at its size. It is protandrous type and need to be grown with protogynous varieties. Medium size nuts are slightly wrinkled, loose in shell but has excellent flavour.

**Exercise - 7**

**Objective: Application of manures and fertilizers in temperate fruit crops**

**Material required:**FYM, Fertilizers, Spade, Basket and Weighing balance.

1. To acquaint the students with different types of fertilizers.
2. To know the fertilizer and manure requirements for different fruit species, their time of application and method of application.

**Introduction:** The temperate fruit trees like other plants remove large quantities of mineral elements from soil for growth, development and fruit production. Fruit trees being perennial stay in soil for a number of years and continuous removal without adequate replenishment of these elements cause partial or complete depletion of available nutrients in the soil. This lag causes reduction both in rate and amount of uptake of these nutrients, growth and productivity of plants. It is, therefore, obvious that a fruit grower needs to replenish these nutrients externally through the application of manures and fertilizers. But each type of fruit species has its own nutrient requirement, so the dose of manures and fertilizers also varies. This will also vary with the inherent capacity of soil to supply nutrients. Under average conditions of the soils of the orchards, the recommended doses of manures and fertilizer are given in the table.

**Methods of application:** For efficient uptake and utilization of nutrients, the method of application of fertilizers to the soils plays an important role. Method depends upon the age of the plant, type of fertilizers and gradient of orchards. The fundamental methods of fertilizers to orchard soil are; broadcasting and placement of fertilizers in bands, strips and basins. When the land is flat and, fruit trees have grown large and their roots have occupied the entire space, the broadcasting method can be followed. The fertilizers are well mixed in the soil and light irrigation is given. Trees with basins, require basin application. In sloppy orchards the fertilizers can be applied by band or dibbling so that the fertilizers and not eroded. sloppy land, the phosphate fertilizers should be applied in holes. Care should be taken while making holes/bands that roots are not damaged. The fertilizers are applied at least 30cm to 60 cm away from the stem depending upon the age of the plant.

**Table 1: Recommended fertilizers schedule for Pome fruits in Himachal Pradesh**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Age of the tree(year)** | **FYM****(kg)** | **N****(g)** | **CAN****(g)** | **P2O5****(g)** | **SSP****(g)** | **K2 O****(g)** | **MOP****(g)** |
| 1 | 10 | 70 | 280 | 35 | 220 | 70 | 115 |
| 2 | 20 | 140 | 560 | 70 | 440 | 140 | 230 |
| 3 | 30 | 210 | 840 | 195 | 660 | 210 | 350 |
| 4 | 40 | 280 | 1120 | 140 | 880 | 280 | 470 |
| 5 | 50 | 350 | 1400 | 175 | 1100 | 350 | 585 |
| 6 | 60 | 420 | 1680 | 210 | 1320 | 420 | 700 |
| 7 | 70 | 500 | 1960 | 245 | 1540 | 500 | 820 |
| 8 | 80 | 560 | 2240 | 280 | 1760 | 560 | 935 |
| 9 | 90 | 630 | 2520 | 315 | 1980 | 630 | 1050 |
| 10 and above | 100 | 700 | 2800 | 350 | 2000 | 700 | 1170 |
| Off year | 100 | 500 | 2000 | 250 | 1560 | 400 | 670 |

**Table 2. The manure and fertilizer schedule for Stone fruits in Himachal Pradesh**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age of tree (yr.)** | **FYM (kg)** | **N (g)** | **P2O5(g)** | **K2O (g)** |
| 1 | 10 | 70 | 35 | 100 |
| 2 | 15 | 140 | 70 | 200 |
| 3 | 20 | 210 | 105 | 300 |
| 4 | 25 | 280 | 140 | 400 |
| 5 | 30 | 350 | 175 | 500 |
| 6 | 35 | 420 | 210 | 600 |
| 7 & above | 40 | 500 | 250 | 700 |

**Table. 3. Doses of manures and fertilizers and their time of application**

|  |  |  |  |
| --- | --- | --- | --- |
| **Fruit plant** | **Age of plant (years)** | **FYM** | **Doses of fertilizers (g/plant)** |
| **(kg / plant)** | **CAN****(25% N)** | **SSP****(16%P2O5)** | **MOP****(60% K2O)** |
| Pome fruits(apple and pear) | Per year of age | 10 | 280 | 220 | 115 |
| 10 years and above | 100 | 2800 | 2200 | 1150 |
| Stone fruits(peach, plum, apricot)almond and cherry | Per year of age with increment of five years | 10 | 280 | 220 | 165 |
| 7 years and above | 40 | 2000 | 1560 | 1200 |
| Kiwifruit | Per year of age with increment of 8 FYM | 10 | 400 | 450 | 350 |
|  | 8 and above | 80 | 3200 | 3600 | 2800 |
| Nuts | Per year of age with increment of 5 FYM | 10 | 2 Kg NPK mixture fertilizer (15:15:15) |  |  |
| 16 and above | 100 | 8 kg NPK mixture fertilizer |  |  |

CAN = Calcium Ammonium Nitrate, SSP = Single Super Phosphate, MOP = Muriate of Potash

**Time of application:**In temperate fruits, apply all FYM, SSP and MOP during December after pruning. Apply half dose of CAN 2-3 weeks before flowering and remaining dose one month after the first application or just after fruit set

**Methods of Application:** Method of application depends up on age of the plant, type of fertilizers and gradient of the orchard. The fundamental methods of fertilizer application to the orchard soils are; broadcasting and placement of fertilizers in bands, strips and basins.

**Broadcasting Method:**It is a cheapest method of spreading the fertilizers uniformly over the entire floor of orchard, and where the fruit plants have grown to large size and their roots have occupied the entire space in the orchard.

**Basin Method:**In this method, the manure and fertilizers are applied in the basins of the fruit trees. This method is applied when the plants are young and/or basins have been prepared.

**Band Method:** The placement of fertilizers is made in bands or trenches around a tree. Care is taken to avoid root injury while digging the bands or trenches. The method is followed in orchards with steep slope and when the fertilizers are applied in small quantity.

**Exercise – 8**

**Objective: Layout systems of temperate fruit orchards**

**Materials required:** Rope and iron chain, measuring tape, ranging rods, cross staff and wooden pegs.

**Lay-out:** Layout means locating the position of trees in an orchard. For laying out an orchard, the baseline is first selected parallel to an adjacent orchard or the main road. At least three points are marked at proper distance from the boundary and ranging rods are fixed. The rope is stretched across the field along one side of the ranging rods. This represents the first row as well as the base line. Now stretch the measuring tape along this row and fix wooden pegs to locate the position of trees leaving proper distance from the ends. Another row or base line at right angle to the first base line is then marked along with other edge of the field with the help of carpenter square or cross-staff. The right angle can also be drawn with the help of measuring tape. One end of this tape is fixed at 3 meter distance along the first row and then the tape is stretched along the second row for a distance of 4 meters. The diagonal distance between these two points should be 5 meters). Similarly, right angle is made at the last point of the base line. Then, the positions of the rows towards either side of the boundary and trees on the first and last rows are marked. The rope is stretched across the corresponding points to get the positions of the plants and finally, wooden pegs are fixed in these positions

**Systems of lay-out:**System of lay-out refers to the orderly way of planting the trees. An orchard lay-out system should have suitability to a particular site of an orchard with respect to its elevation and topography.

**The following seven layout systems are usually followed for planting of temperate fruits orchard.**

**Square system:**In this system, as the name indicates, the distance from plant to plant and row to row is the same. The plants are at right angle to each other so that every units of four plants forms a square. This is the most common system and is easy to layout. This facilitates intercultural in two directions.



**Rectangular system:**The trees are planted in straight rows running at right angles on one side of the field. The distance from plant to plant and row to row is not the same and four trees joined at the base give a rectangle. Like square system, cultivation, irrigation and other intercultural operations can be done in two directions.



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**Hexagonal system:**In this system, the trees are planted in each corner of an equilateral triangle, thus six trees in a hexagon and seventh in the centre. This system differs from a square system in a way that the distance between the row is less than the distance between the trees in a row, but distance from tree to tree in six directions remains the same. This permits cultivation in three directions. This system can be employed where the land is very fertile with assured irrigation.



**Diagonal or Quincunx system:**It is the same as the square system with an additional plant in the centre of a square. The central tree is usually not a permanent tree and is planted to fill the central space. This is known as filler. Filler serves as a source of additional income till the main trees comes into bearing. Papaya in mango and peach in apple orchards can be planted as filler trees. For laying out this system, the field is laid out in similar ways as in square system. Then, the rope is stretched through the diagonal points of the squares and additional pegs are fixed at the points where diagonals cross each other.



**Triangular system:**The trees are planted as in the square system except the plants which are in the even numbered rows are midway between, instead of opposite to those in the odd numbered rows. Every second row accommodates one plant less than the square system. And for laying out an orchard according to the triangular system, a large triangle with a ring in each corner as used in hexagonal system. The sides of this triangle are equal to the distance to be kept for the plants in the orchard. Two of these rings are placed on the stakes of base line. The position of the third ring indicates the position of plant in the second row. This row is then used as a base line. The whole area is laid out in this manner. However, this system is not of practical importance.



**Contour system:**This system is usually followed in the hilly areas with undulating topography. The positions of plants are marked at various heights from mean sea level. The points having the same altitude are connected together by a line and trees are given spacing on this line. The rows are represented by line passing through the same contour.

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**Terrace planting:**This is also commonly followed in hilly areas. On the steeper slopes, terraces are made along the contour and then planting is done. The width of contour terrace varies according to the nature of the slope. If the slope becomes steep, the width of terrace is narrower and vice versa. Bench terracing is the most popular system in hilly areas



**Spacing of temperate fruit plants**The planting distance for a particular fruit tree is determined by various factors like kind of fruit tree and its growth habit, rootstock used, pruning and training needs, rainfall of the area and soil conditions etc., but the common distance for most of the fruit trees is given here under:

The best time of planting of temperate fruits are January and February. Before planting, orchard site is properly laid out, after layout of an orchard; the pits of 1x1x1 m size are dug one month before the planting. The pits are filled with soils in which 40-50 kg well rotten FYM and 1 kg single super phosphate are mixed.

**Exercise – 9**

**Objective: Preparation and uses of plant growth regulators in temperate fruits**

**Calculating the strength of growth regulators:** Strength of growth regulators is calculated in ppm (part per million) ppm is the mg of chemical dissolved in one liter of water e.g. 5 ppm means 5 mg salt dissolved in one liter of solvent. Following table will tell the inter conversion of hormonal strength

|  |  |  |  |
| --- | --- | --- | --- |
| **Per cent solution (%)** | **Miligram/litre****(mg/l)** | **Parts per million (ppm)** | **Grams/litre (g/l)** |
| 100 | 1,000,000 | 1,000,000 | 1000 |
| 10 | 100,000 | 100,000 | 100 |
| 1 | 10,000 | 10,000 | 10 |
| 0.1 | 1,000 | 1,000 | 1 |
| 0.01 | 100 | 100 | 0.1 |
| 0.001 | 10 | 10 | 0.01 |
| 0.0001 | 1 | 1 | 0.001 |

|  |  |
| --- | --- |
| Percentage = | Ppm |
| 10,000 |
|   ppm = % x 10000 |
|  ppm = % x 104 |

**Preparation of growth regulator solution** Weigh the required quantity of growth regulator. The quantity of chemical required will depend on volume and strength of the solution to be prepared and the purity of chemical used. In case the chemical is liquid, measure the required quantity with the help of a pipette or syringe. It is always desirable to prepare the solution of higher strength as the lower concentration can be prepared easily by dilution. After weighing the chemical transfer it to a beaker and dissolve it with the suitable solvent. Shake the beaker till the chemical is fully dissolved. Now transfer it into volumetric flask and at necessary quantity of distilled water. For every use prepare a fresh solution.

**The common uses of PGRs in fruit crops are as under:**

**Propagation:** PGRs are being used commercially for rooting of cuttings, layering and seed germination.

**Rooting of cuttings:**The prepared cuttings should be treated with the growth regulator solution as soon as possible, and put the growth regulator solution in the beakers. Label the beakers properly with glass marking pencil. Make bundles of 10 or more cuttings for each concentration of individual growth regulator solution. Put the basal ends of cuttings in the solution. At least 2-3 cms of cuttings must be dipped inside the solution. Leave the cuttings in the solution to the desired time. In one beaker take distilled water and keep same number of cuttings for same duration of time as allowed in growth regulator solution. After the specific duration remove the cuttings from the solution and wash them with plain water and plant them in the medium already prepared. Commonly used hormones for rooting are as:

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No.** | **Name of growth regulator** | **Suggested concentration (ppm)** | **Remarks** |
|  |  | Quick dip | Prolonged dip |  |
| 1 | Indole acetic acid (IAA) | 500-1500 | 100-500 | Roots produce are thicker and shorter |
| 2 | Indole butyric acid (IBA) | 500-1500 | 100-500 | More fibrous roots are produce hormones not toxic even at higher concentrations. Move slowly within the plant and destroyed slowly by auxin destroying enzymes. Excellent rooting hormones |
| 3 | Naphthalene acetic acid (NAA) | 500-1500 | 100-500 | This hormone is toxic if used at higher concentration |

**Treating cuttings with growth regulator powder:**Take distilled water in a beaker. Dip the basal end of the cuttings in water. Only one to two centimeter basal end of the cuttings should be moistened. Dip the moistened end of cuttings directly in the growth regulator powder and immediately planted in rooting media in usual manner. Treating cuttings in talc powder is not satisfactory because the growth regulators are not evenly distributed in the talc powder.

**Use of growth regulators in layering:**First weigh the watch glass. Then put lanolin paste on the watch glass with the help of a glass rod. Weigh it again to get the weight of the lanolin paste. Weigh the growth regulator and dissolve it in suitable solvent. Heat the watch glass by putting it on a low flame.

As paste melts add the growth regulator solution. Mix the solution with glass rod till homogenous mixture is formed. Remove it from the flame and let it cool. Prepare the air layer and apply the paste with the help of a glass rod on the upper side ringed area. The following growth regulators and their mixtures have been found to be effective on large number of plants in inducing routings in layering:

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Name of growth regulator** | **Suggested concentrations (ppm)** |
| 1 | Naphthalene acetic acid (NAA) | 1000-10000 |
| 2 | Indole butyric acid (IBA) | 1000-10000 |
| 3 | Indole acetic acid (IAA) | 1000-10000 |
| 4 | 2,4 Dichlorophenoxy acetic acid (2,4-D) | 250-500 |
| 5 | NAA+2,4-D | 5000+250 |
| 6 | IBA + 2,4-D | 5000+250 |

**Germination:** GA3 200 ppm has been successfully used for enhancing seed germination in apple, pear and stone fruits.

**Fruit set:**In apple, spray of miraculan 0.75 ml/l and paras 0.6 ml/l or biozyme or protozyme 2 ml/l at bud swell stage and repeated after petal fall stage improve fruit set and yield.

**Fruit drop:** In apple and pear spray of 10 ppm NAA about a week before expected fruit drop prevent fruit drop.

**Fruit Thinning:** It has been observed heavy bearing in apple, pear and stone fruits during !on year!, results in small sized poor quality fruits. Therefore, judicious thinning at proper stage of fruit development is must to regulate cropping and improving fruit size and quality.

The thinning can be achieved either by manually or with the use of growth regulators. Foliar sprays of 20 ppm NAA at petal fall results in optimum fruit thinning In peaches application of Ethephone (2-Chloromethyi Phosphonic Acid i,e. CEPA) 300 ppm at petal fall in July Elberta is recommended for optimum fruit thinning. However, in Red haven peach, Ethaphone (600ppm) 20-30 days after fruit set when the fruit lets are 20-25 cm in diameter, should be used for thinning.

**Improvement of fruit colour and enhancement of maturity:** In apple spray of 1200 ppm ethephone about a week before expected harvest improve fruit colour in mid hills and enhance fruit maturity in high hills. 25 ppm NAA should also be mixed with ethereal to prevent excessive fruit drop caused by ethereal. In plum spray of 500 ppm etheral about a week before harvest improve fruit colour. In apricot and peaches 2,4,5-T, 2,4-D, NAA or TIBA enhances fruit ripening and improve fruit colour and flavour.

**Dormancy:** Benzyl adenine (BA) 500 ppm and gibberellins 50 –200 ppm are effective regulators in breaking dormancy. Other chemicals used to break dormancy in fruit crops are Dinitro-ortho-cresol DNOC 1.5% as dormant spray; KNO3 2-5% helps in promoting more flower bud opening, Thiourea 2% promote more leaf bud opening and GA3 most effective in breaking dormancy in cherry and peaches.

**Exercise- 10**

**Objective:**[**Training and pruning**](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79048)**of pome (apple and pear) fruit trees**

**Material required:** Secateurs, pruning saw, branch spreader, Bordeaux paint or Chaubattia paste and ladder.

**Training:** Training is done to shape or build a strong framework of the trees in order to support maximum crop when plant reaches bearing stage.

There are several systems of training in apple especially for dwarf plantations like spindle bush, dwarf pyramid and cylinder spindle etc., but modified central leader system is most suitable for standard plantation.

**Modified central leader system:** Generally, one year old whip grafting tree without a single branch is planted in the dormant season. Immediately after transplanting the tip of plant is headed back 60 to 75 cm above the ground level. In the following summer, most of the buds on main branch will sprout. In order to develop clean stem up to 45 cm from the ground the sprouted buds are pinched off soon after their appearance. Three or four well spaced buds projecting in opposite directions are retained with lowest one 45 cm above ground. If summer pruning is not done, then 3-4 well spaced primary branches having wider crotch angle are selected during dormant pruning. The selected branches should be spaced 10-15 cm apart in spiral fashion. The branches emerging below 30 cm from ground level and other undesirable branches are pruned off. The selected branches are headed back to ¼ of growth to a bud projecting to the outer direction. The leader is also headed back to 30 cm above the last branch. During the second dormant pruning, 2-3 well spaced primary branches are selected on the leader. On the primary branches selected during previous year, two secondary branches which are growing outward direction should be selected. The selected primary and secondary branches are headed back to 1/3 - ¼ of the growth. The secondary and tertiary branches selected should be spreading horizontally and upright or down ward growing branches should be removed. The third year training consists of thinning out of unwanted branches and heading back of desirable side branches. The central leader should be headed back to a bud or weak shoot, which will develop in the form of a side branch. By fourth year training should be completed.



**Training of dwarf apple tree:** With the [introduction](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79091) of clonal rootstocks and spur type cultivars of apple the tree trunk of the plants is short and head is close to the ground. Various methods of training viz. spindle bush, dwarf pyramids, cordons, palmate and espalier have been developed in different countries of the world but Spindle bush system of training is commonly followed for apple in India.



**Procedure:** One year old apple plants are cut back to a bud about 60 cm above the ground. During the first summer 2 to 3 laterals or feathers 30 cm above from the base may be used to form the main scaffold branches such branches should be well spaced all around the stem. If the growth is moderate to weak during the first summer, tying down of feathers/branches are not required. If they are vigorous then can be tied in August when the growth has stopped. Tying is done by putting loops around the shoot and tightening the other end to pegs pushed into the ground. For spreading since they are tender can be made by cloth pins at this stage. During first winter season, 2 to 3 well spaced laterals should be retained and unwanted branches arising on the main stem should be cut out. The weak scaffold old branches may be cut back by 1/3 to 1/2of their length to a downward growing stem, whereas if healthy should be thinned out. During the August of the second year when growth has stopped, strong growing laterals are tied down to form branches. In second winter season to check excessive vigour of the central leader, it may again to be cut back to the next suitably placed rather weaker growing lateral which is tied and trained again into take the place of the central leader.

Delaying pruning until late winter or early spring will also help check vigour. During subsequent growth the branches are allowed to grow from the central leader at regular intervals, choosing wide angle shoots. The higher placed branches must be kept shorter that the lower ones to allow sufficient light to reach the lower parts of the tree. In order to keep sufficient wood in the spindle bush while it is being built up a small surplus of the wide angled branches is retained which may cut out as they require more space. The main branches should be trained and spaced so that there is plenty of room for fruiting laterals.

**Treatment of Wounds:**The cuts less than 2.5 cm in diameter heal themselves, but there is a danger of infection in the bigger cuts which should be covered with Bordeaux paste or Chaubatia paste.

**Pruning of apple and pear tree:**

**Pruning:** The objective of pruning is to maintain a proper balance between vegetative growth and spur development. The training is completed during initial 4-5 years after planting of plant, but pruning is continued after training throughout the life of tree. In pruning, thinning out and heading back are two basic components. The pruning consists of thinning out of all upright laterals and those growing inside the trees and heading back of leaders and laterals. In apple, the fruit in obtained not only spurs but also on fruit buds on young laterals. Therefore, pruning should be done in such a way that continuous supply of new, healthy shoots, spurs and branches are maintained. While pruning, some part of tree is pruned and some left unpruned. The pruned parts produced shoot growth and unpruned parts will produce fruit buds. The laterals which have left unpruned in one year may be either shortened or left unpruned in the next year depending on the growth, spur formation and crop load. Once the laterals have cropped and become weak, they must be severely shortened leaving them 5-6 cm long. The severe shortening will promote the production of new growth from these stubs, which in two years will give a crop. The whole cycle is accordingly repeated every year to ensure regular growth, spur formation and cropping. At the time of pruning dead, diseased and broken branches are removed and on the cut surface Chaubattia or Bordeaux paste are applied to avoid any fungal infection. The best time of pruning is during dormant season (December to January).

**Exercise-11**

**Objective:**[**Training and pruning**](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79048)**of stone fruits**

**Objectives:**To learn and practice different systems of [training and pruning](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79048) in stone fruits.

**Materials:** Secateure, pruning saw, branch spreader, Bordeaux paint or Chaubattia paste and ladder.

**Training:** The stone fruits are mostly trained to open centre system of training; however, under high density plantation tatura system is adopted.

**Open Centre System:** After planting, the plant is cut back to 40-60 cm above the ground level. During the growing season, about 3 to 6 laterals, in addition to the central leader are produced on the tree. In the first winter pruning, 3 to 4 scaffold branches which are well located and have wide angle should be selected and remaining unwanted branches are removed. The central leader is also completely removed. The selected branches are headed back to ¼ to ½ of the growth. During the second dormant pruning, 2-3 secondary branches are selected on the primary branches. The major consideration in selecting secondary branches should be their location so that after pruning, the tips of primary and secondary leaders is about 30-40 cm apart from each other. The height of secondary branches is staggered in different years by pruning all branch leader more severely. The vertical ones are pruned more severely. This will produce branch leaders at different heights and prevent overcrowding when the tree is mature. In the following years, the head should be fully formed and selection of secondary branches is completed.



**Tatura trellis system:** In high density planting, this system of training of plants is very popular being very yield efficient. Trees are planted at a spacing of 5x1m or 6x1m. At the time of planting, one year old plant is headed back to 20 cm above the ground level. In next growing season two limbs or branches are selected in opposite directions and these branches are trained across the inter row space at an angle of 60 degree from the horizontal, forming V-shaped canopy. The canopy is supported by a permanent trellis constructed of high tensile galvanized steel fence posts. The secondary branches are developed along each primary branches forming fruiting canopy.



**Pruning** The main objective of pruning is to maintain balance between vegetative growth and fruiting. Bearing peach require heavy and regular pruning because it bear fruits laterally on the previous season growth. It is known, once a growth has fruited will never bear again in its life. Therefore, pruning is done to remove the unproductive parts which in turn will form new fruiting branches in the following season. In peach pruning, thinning and heading back of shoots are two basic components. Pruning should be done so as to produce 30-70 cm of growth under subtropical conditions and 25-30 cm under mid hills, annually, which is sufficient for optimum fruit production. For good quality fruit production, 40-50 per cent of thinning out and 75% heading back of shoots is suggested under mid hills conditions. At the time of pruning, dead, diseased and broken branches are pruned off.

**Apricot:** In young bearing trees pruning should be light and of corrective type but in older trees heavy pruning should be done to maintain balance between growth and fruiting. In new castle apricot, 25-30 percent thinning of one year old shoots and 1/3rd heading back is recommended to improve size and fruit quality.

**Plum:** In plums, thinning and heading back of shoots are two basic components of pruning. Most of plum [varieties](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79025) bear on spurs on two years old wood. The life span of these spurs is 5-6 years. It is necessary to prune for some spur renewal each season. The extent of pruning is done such a way to induce an annual shoot growth of 25-50 cm. In bearing plum trees, 25-30 percent thinning of shoots and 50-75 per cent heading back of shoots is suggested for proper fruiting. At the time of pruning, dead, diseased and broken branches should be pruned off.

**Exercise - 12**

**Objective:**[**Training and pruning**](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=79048)**of kiwifruit**

**Training: -** Kiwifruit is a vine like grape, thus require similar training structure but stronger than grapes. A number of training structures are used for training a vine, but T- bar trellis and pergola systems are more popular. In T- bar trellis system, the pillars of iron and concrete about 1.8m in height above the ground level are erected at a distance of 6m from each other in a row in straight line. A cross arm (1.5m) is fixed on each pole, which carries five outriggers wire at a distance of 45 cm each Vines are trained up to wire as single stem then two leaders in opposite direction along the center wire are selected or developed . From these permanent leaders, temporary fruiting arms 25-30 cm apart are selected at right angle along both sides of each leader. Training of vines on pergola system is similar to that of T-bar. A flat topped network of criss-cross wire is prepared on the erected pillars. This systems is costly to prepare but vine trained on this system gives higher yields.



**Pruning:-**The main objective of pruning is to obtain high yield of quality fruits and to manage excessive vegetative growth.

**The following principles should be kept in mind at the time of pruning**.

1. The fruit is developed on current season’s growth arising from one year shoot.
2. Only the basal buds of the nodes 4-12 on current season growth are productive.
3. Vines grow 2-3 m every year, which become overcrowded if not controlled by summer and winter pruning.
4. The shoots developed on older wood by heading back will not fruit normally in the first season.

Keeping in mind these principles, the vine pruning are carried out in such a way, that the fruiting areas are available every year requiring the wood to be young. This is achieved by 3-4 years lateral replacement system. In dormant pruning, the fruiting lateral is cut back to 2 vegetative buds beyond the last fruit. In the second year, these vegetative buds produce the fruiting shoots, which are pruned again. The arm on lateral shoots are pruned and allowed to fruit for 3-4 years. After this the lateral is removed from the main branches and other laterals are selected and pruned accordingly so that the balance between vegetative and reproductive growth is maintained for the continuity in the fruit production. In summer pruning shoot is cut .beyond 6-8 buds from the last fruit during June-July.



**Exercise - 13**

**Objective: Visit to private orchards to diagnose maladies in fruit crops**

“Seeing is believing-

Learning by doing”

**Aim:**

* To acquire practical knowledge on the maladies in different fruit crops of the farmers field.
* Students/farmers interaction on diagnosis of the different maladies in fruits.

In these practicals, students shall be taken to the fruit orchards of progressive fruit growers. They will be given practical knowledge about management practices being followed by the farmers developed by the Universities and other research institutes on scientific lines. Students will interact with the farmers about adoption developed technologies on fruit production, economic feasibility of different production systems, difficulties if any faced by the farmers in adopting the developed technologies and acquire knowledge about marketing systems.

Students shall also be involved in demonstrating and/disseminating recently developed technologies by the universities and other research centers.

**Observations:** Record the following observations on the farmer’s orchards:

* Name of the farmer/orchardist:
* Land holding:
* Kind of fruit crops being raised:
* Planting distance:
* Type of management practices being followed:
* Number of trees of different fruit crops:
* Maladies recorded in the different fruit trees in the orchards:
* Annual crop yield:
* Net return:

Based on the above observations, draw your inference.