

PRODUCTION TECHNOLOGY OF APPLE

By

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INTRODUCTION:

Apple (*Malus domestica*) belongs to the genus *Malus*, Family Rosaceae, the great family of the roses, which includes not only the apples but also several other fruits such as peaches, pears, plums and raspberries. *Malus* genus has no grit cells. Styles are united at the base. Flowers are colored and fruit is globular. Flowers are perfect with 5 petals, sepals, carpels, 2 ovules and 15-20 stamens. Tree is upright spreading, deciduous, carries mix buds, produce flowers and leaves in spurs and fruit is technically a pome.



The successful production of apple requires long growing season, adequate sunshine a plentiful supply of moisture, mild winter and protection from strong winds. Accordingly the Balochistan climate is well suited for production of high quality apple; however the Murree Hills and Soan Valley are prominent places in Punjab where the Apples can be grown successfully. Apple trees can endure temperature as low as 31 °F to 40 °F

At Murree and its allied area i.e. Chitta Morgh, Ghora Gali, New Murree, Upper Topa, Lower Topa, Alliot, Bhurban and Khaira Gali; the high chilling varieties of apple and other deciduous fruits can be grown successfully while in areas of Soan Valley, Tret, Phagwari, Kotli Sattian, lower devil, Berot, Lora, Charhan and Kohala, the low chilling varieties of apple can be grown.

NOMENCLATURE & BOTANY

- English Name Apple
- Technical Name *Malus domestica*
- Family *Rosaceae* (A great family of fruits such as peaches, plums, pears and raspberries)
- Sub-Family *Pomoideae*
- Apple is superior fruit developed from the floral receptacle, which after fertilization becomes swollen, and edible.

Apple is important in international trade and domestic economy of several countries in cooler climates. Because of its high nutritional value, and popular uses in processed products like juice, preserves, and dairy or bakery items, apple is favourite of billions of people around the world.

ORIGIN AND HISTORY:

Apple is one of the oldest fruit in the world and is native to Southwestern Asia and European countries. It has been found wild in most temperate parts of the world and cooler higher hills of sub-tropical areas. It was, probably first domesticated in the caucasus, and fast spread all over Europe, even in pre-historical times. Apples spread from Europe to USA, Australia and South America. In Pakistan various forms of apple showing great diversity in size, shape, color and taste are grown from the time immemorial, particularly at higher elevations (about 1300m) in areas adjoining Afghanistan, Iran and China.

NUTRITIVE VALUE:

Nutrients: Content per 100 g		
Energy 229 kJ (54 kcal)	Vitamins	Tyr 5 mg
Water 85.3 g	Carotene 45 µg	Val 12 mg
Protein 0.3 g	Vitamin E 490 µg	
Lipids 0.4 g	Vitamin K 0-5 µg	Carbohydrates
Carbohydrate 11.8 g	Vitamin B1 35 µg	Glucose 2210 mg
Organic acids 0.6 g	Vitamin B2 30 µg	Fructose 6040 mg
Fiber 2.3 g	Nicotinamide 300 µg	Sucrose 2470 mg
Minerals 0.3 g	Pantothenic acid 100 µg	Starch 600 mg
	Vitamin B6 45 µg	Sorbit 510 mg
Minerals	Biotin 1-8 µg	
Sodium 3 mg	Folic acid 7 µg	Lipids
Potassium 145 mg	Vitamin C 12 mg	Palmitic acid 50 mg
Magnesium 6 mg		Stearic acid 10 mg
Calcium 7 mg	Amino Acids	Oleic acid 20 mg
Manganese 65 µg	Arg 8 mg	Linolic acid 100 mg
Iron 480 µg	His 6 mg	Linoleic acid 20 mg
Copper 100 µg	Ile 10 mg	
Zinc 120 µg	Leu 16 mg	Other
Phosphorus 12 mg	Lys 15 mg	Malic acid 550 mg
Chloride 2 mg	Met 3 mg	Citric acid 16 mg
Fluoride 7 µg	Phe 9 mg	Oxalic acid 500 µg
Iodine 2 µg	Thr 8 mg	Salicylic acid 310 µg
Selenium 1-6 µg	Trp 2 mg	Purines 3 mg
tent per 100 g		
Energy 229 kJ (54 kcal)	Vitamins	Tyr 5 mg

Reference: Deutsche Forschungsanstalt für Lebensmittelchemie, Garching bei München (ed), Der kleine "Souci-Fachmann-Kraut" Lebensmitteltabelle für die Praxis, WVG, Stuttgart 1991.

MEDICINAL VALUE:

The apple fruit is a highly nutritive food that contains minerals and vitamins in abundance. The food value of the apple is chiefly constituted by its contents of sugar which ranges from 9 to 51 per cent. Apple fruit sugars constitute 60 percent and glucose 25 percent and cane sugar only 15 per cent.

Kidney stones can be cured by regular use of apples. The skin of apple is of much use and should not be discarded while eating as it contains more vitamin-C and vitamin A than the inner flesh. The vitamin content decreases gradually towards the center of the fruit. For formation of blood iron content in fruit is of prime importance. Raw apples are good for constipation and also cooked or baked apples are good for diarrhea. Apples are thought to be very useful in acute and chronic dysentery among children. Apples are equally useful for heart patients. They are rich in potassium and phosphorus but low in sodium. Apples are useful for the patients of high blood pressure and gout patients caused by increase of uric acid in blood. Different diseases of eyes can be cured by apple eating. As an eye wash, Apple peel water can cure inflamed eyes. The over-ripe apples are useful as a poultice for sore eyes. The pulp is applied over the closed eyes. Tooth-decay can be prevented by regular consumption of apples as they possess a mouth cleansing property. The apple is the best fruit to tone up a weak and run-down patient. It removes deficiencies of vital organs and makes the body stout and strong. It tones up the body and the brain as it contains more phosphorus and iron than any other fruit or vegetable.

CLIMATE

1. TEMPERATURE:

Apple is a temperate fruit and generally grown in temperate regions and requires a cool climate for its proper growth and development. A certain minimum chilling period is needed for fruiting, in its absence the buds may not open or blossoming may be uneven. This chilling process takes place at temperature below 7°C(45°F) most apple varieties need to experience such temperature for about 1200 hours in order to achieve and complete an adequate rest while some varieties can manage with as little as 250 hours.

2. MOISTURE AND RAINFALL:

Apple can grow in a wide range of rainfall from evenly spread rains of 25 to 37 cm (10-15) per year to heavy seasonal rainfall of 125 to 175 cm (50-70). Where the rainfall is heavy, extensive drainage is required to prevent water logging. Certain minimum soil moisture is necessary for the proper growth and the development of the tree. Growing apples in arid climate, will be subject to continuous water stress conditions and leads to low cropping capacity.

3. ALTITUDE:

In Pakistan the apples can be grown at altitude ranging from 1350 to 2600 m (4500-4800). The major advantage of planting an apple orchard at relatively lower altitude and in warmer areas is that the fruit is ready for market before the season and hence fetch a better price. On the other hand, the disadvantage is that the orchard will be prone to more insect and disease attacks, because insect and fungi multiply much faster in a warm climate.

4. SLOPE OF LAND

An apple tree is very versatile and can grow on level grounds as well as on considerably steep gradients. However, land having very steep gradients has the disadvantages of operations of pruning, picking, spraying and cultivation which is more expensive and difficult. The form cannot be mechanized. There is loss of fertilizer by leaching. Cultivation may lead to erosion. Because of poor root anchorage the dwarfing rootstocks cannot be planted. However, a gentle slope, which could perhaps be converted into terraces before planting a tree, is preferable to a steep slope.

5. FROST POCKETS

For successful apple cultivation, a site which is prone to frost, must be avoided. Spring frost, can cause very heavy damage to the apple crop which is also the limiting factor in Murree Hills. It can kill or damage the blossoms or prevent the proper fertilization of the blossoms.

6. HAIL ZONES:

Certain areas are known to be hail zones, which must be avoided while selecting a site for the orchards. Hail can cause immense damage and there is no insurance against hail in Pakistan yet. One heavy hail storm can reduce the value of crop upto 80% and renders the entire crop fit only for processing.

7. WATER RESOURCE

Under normal circumstances, if the apple orchard is located on a site above 1800 m (6000) altitude, requires little irrigation. However, trees, which are planted at lower elevation or in areas, which are prone to draught conditions or planted on sandy soils, may require irrigation. Similarly dwarfing root stocks like M.9, MM.106, M.4 etc., also prefer adequate moisture.

SOIL

Apple can be grown on wide range of soils including deep rich, well-drained, fertile loam soils, which enables free root development. Water logged soils or where sub-soil water rises into the root zone, even for a short time, during the growth period should be avoided. Light, shallow, gravel soils, which are not capable of retaining adequate moisture, are also undesirable for Apple cultivation. Apples prefer fairly acidic to slightly alkaline soils with pH range 6.0 to 6.5. Soils must contain at least 3% organic matter in the top 22 cm (9) of the soil. The sub soil should be free of hard pan, sticky clay and water logged conditions.

PROPAGATION:

SEXUAL METHOD

Mostly Apples rootstocks are propagated by seeds. For raising apple rootstock from seed, the fruit of ordinary crab apple may be collected in May-June from the plains or in July from the hills. The seed may be extracted and stored in a cool, dry place till December, when it is either sown directly in the soil or is subjected to stratification in boxes. The seeds sown in early December on beds remain dormant till the season warms up in March when they germinate. When the seedlings are 2-4 inches high they are transplanted and become fit for budding in the following summer.

Stratification is usually done in November-December, and the seeds are planted in February-March in the seed bed for one season and the seedlings are transplanted in the nursery row in the following winter or early spring. The usual method of stratification (Pre-sowing treatment) is to place the seeds in alternate layers of moist sand in shallow boxes, flat pits or trenches and subjecting them to cold or more generally freezing temperatures. But in European countries nursery men have developed their own special methods which involve the use of crude acids, hot water, oven-baking and chilling of suitable combination of these methods.

Following are the rootstocks used commonly:

Vigorous	Crab apple, Robusto, M16 and M109
Semi Vigorous	MM 111, M4, MM104 and MM111
Semi Dwarf	M7and MM106
Dwarf	MM9, MM26 and MM27

ASEXUAL METHOD

There are many methods of budding and grafting like Ring budding, Shield or “T” Budding T-Grafting, Side grafting Whip or tongue grafting but the most popular and successful method is cleft grafting.

Vegetative production of rootstocks is usually accomplished by stooling and rarely by layering and root-cutting. Almost all malling types of rootstocks and the crab apple which is used in Murree.

In Murree and Soan Valley the mature apple plants sends out the sprouts from the soil and these are collected from the field and are transplanted during the month of August-September. Further these are grafted during the month of February-March via cleft Grafting.

CRITERIA FOR THE SELECTION OF VARIETIES:

1. The cultivar should be annual bearer.
2. It should be able to bear fruit fairly early in life.
3. It should be hardy and respectively annual bearer.
4. It should be able to produce the fruit of good size.
5. The fruit should be of good appearance.
6. The fruit should have a good to very good desert quality, i.e. it should be crispy, sweet, not too acidic, and have reasonable shelf life.
7. The skin of the fruit should be hard enough to absorb minor hail damage.

VARIETIES

Low chilling Varieties Suitable for plantation at Soan Valley and comparative warm areas	High chilling varieties suitable for colder area like Murree Hills
Anna, Tropical Beauty, Enshiemer, Apple No-1, Early Shan Burry, Pink Lady and Kandhari	Saharni, King Red delicious, Star King Delicious, Red Golden, Kashmiri Amri, Mashadi, Kandhari, Kids Orange Red, Mc. Intosh, Golden Delicious, Kapani Red, Ida Red, Beauty, of Bath, Golden Russet, English No.2, English No.3, Winter Banana, Khura Seb, Early Shan Berey, Red Delicious, Golden Lebanon, Amri, Sky Spur, Double Red Delicious, Melrose, Sky Lime Supreme, Nugget MM-III, Oregon Spur Franco, Annurca MM-106, Summer Red, Naga FU 2, Jona Gold, Gala Must, Sparton, Red Chief

METHOD OF LAYOUT

Mostly in Hills the terraces are formed. The land of the terraces is leveled and the plantation is carried out during the month of February and March. In the plains proper layout system is followed. Mostly the square system of layout is recommended. This system facilitates the execution of cultural and other management practices. Generally apples are grown at a distance of 18-20 feet from plant to plant and row to row distance. It must be kept in mind that layout of the orchard should be started from the direction where main road is situated. In more precise words the front of the orchard should be along the main road. To start with the layout, first of all a base line that should be half of the plant to plant distance should be drawn. For example, in apple plant to plant distance is kept at 20 feet and the base line should be drawn at 10 feet from border line. Such a base line must be drawn along the both lengths and breadths of the given piece of land. Parallel to these lines other lines at a given distances should be drawn out and location of plants on these lines should be assessed with measuring tape. On this ear marked points wooden stick should be erected.

High density plantation

The population of the country is increasing day by day but the land is the same so to fulfill the food demand of the population it is necessary to produce more on present land resources. Also it has come to notice that the contractors of the agriculture produce invest on the basis of number of fruits rather area. So the attempts have been made to design the layout system for high density plantation to cope more number of plants on limited land resources.

1. The line to line distance is kept 22 feet and plant to plant distance is kept 18 feet. Care should be taken the direction of lines must be kept from North to South for evenly distribution of light and air circulation. By this layout 108 plants can be planted in one acre.
2. The line to line distance is kept 22 feet and plant to plant distance is kept 15 feet. Care should be taken the direction of lines must be kept from North to South for evenly distribution of light and air circulation. By this layout 126 plants can be planted in one acre.

Note:

After five to six years the plant canopies along the line will be mix with each other. For that the maximum pruning is needed to maintain the canopy volume. As the new growth will be more the plant will also bear more.

DIGGING OF PITS

Digging of pits for pit plantation is necessary for making the orchard enterprise a real success. After proper layout and pinpointing of locations where plants are to be raised a pit measuring 3x3x3 feet is dug out well ahead of the actual planting keeping in view seasonality factor. In the province of Punjab apple is planted after winter season and preferably during late November or early December. Pits are therefore dug out 30 days before actual plantation and should be kept open.

FILLING OF PITS

Filling of pits must be carried out at least 15 days before plantation. Filling material is prepared in such a way that upper 1 foot soil that was separated at the time of pit digging is mixed with the equal volume of farm yard manure and silt and the pits are filled with the prepared mixture. Care should be taken that farm yard manure should be well decomposed.

PLANTING SEASON

Apple is deciduous in nature and can be successfully planted either in spring. In Punjab, in the background of an elaborated research on evaluating a suitable season, spring plantation is preferred. .

PLANTING METHOD

After filling up the pits and locating/marketing the exact point where plants are to be raised, a hole slightly bigger than the root area is dug and the plant in strict upright direction is planted in such a way that the root portion should remain slightly higher than the ground level. The soil around the stem is firmly pressed but without injuring the roots. It should be kept in mind that at the time of planting/grafted portion must remain well above the ground level. Soon after planting irrigation water should be applied.

After Care

- The young newly planted trees should be cut back about one third to establish a favorable balance between the top and the roots and to allow the lateral branches for their proper growth and development. Preferably just after plantation this operation should be carried out.
- In windy location, stacking of plants must be done.
- Plants should be kept under continuous vigil and watering should be done sooner the soil dry up.
- No sprouting from rootstock portion should be allowed to flourish. It must be rubbed off regularly.
- During rainy season water should not be allowed to stagnate in the basins of newly planted tree and it must be channeled out for the proper oxygenation of plant roots.
- During frosty nights irrigation should be performed necessarily.
- Where there is a menace of termites drench the root zone with suitable acaricide. Generally Chloropyripos or larsban produces good results.

IRRIGATION:

Apples need judicious irrigation. Generally growers kept the orchard under high water regimes thereby creating conditions for the spread of phytophthora root rot and de-oxygenation of the root zone. Too much irrigation is not only a waste of money but is highly detrimental to tree health, yield and fruit size whereas the too little irrigation is conducive to stress the trees with the consequential effects of poor productivity and deterioration in quality. In Soan Valley the irrigation is carried out by modified channel system. In some developed orchards the bubbler system are also installed. Following irrigation schedule may be followed; however time of irrigation, interval and quantity of water may be adjusted according to the soil type, climatic condition and weather of locality.

June to July	15-20 days interval
August to September	Subject to rainfall
December to January	Dormant season (No irrigation)
February to March	20-25 days interval

In the Murree Hills there are sufficient rains which meet the irrigational requirements, however during the months of low rain fall (March to June) water requirement is covered by springs. No irrigation should be given during the period of flowering.

IRRIGATION

Irrigation of apple orchards is a major area of potential improvement in view of the reason that haphazard irrigation practices adopted by our apple growers are jeopardizing our apple groves at a rapid pace.

INTER-CROPPING

It has been commonly observed that inter-cropping of harmful crops is one of the chief reasons of early decline of apple orchards, low yields and poor fruit quality. Our Apple growers in Soan Valley grow such type of inter-cropping which have different cultural and management practices than that of fruit plants. Aggravating to the situation is the growing of crops having high water requirements. Following lines will provide guidance about the inter-cropping in apple groves.

1. Inter-cropping of exhaustive, high water intensive and tall growing crops are harmful to apple groves, therefore, Crops like Wheat, Cotton, Sugarcane, Rice, Barseem, Sorghum, Maize should not be grown.
2. Inter-cropping in apple groves can be done in young plantations till the plants start bearing fruits.
3. Inter-cropping should be avoided in full grown orchards.
4. Inter-cropping of Tobacco, Tomatoes, Brinjal, and Chillies is prohibited as their cultivation cause the development of root knot nematodes.
5. Before bearing stage inter-cropping of Kharif and Rabi vegetables is recommended.

Kharif Vegetables:

Onion, Tinda, Bittergourd and other Cucurbits.

Rabi Vegetables:

Peas, Cauliflower, Carrot, Reddish etc.

6. Inter-cropping of Leguminous crops like Mung, Masoor and Grams is recommended
7. Janter and Guara can be sown as green manure crop which should be buried into the soil after 8 – 10 weeks of sowing.

APPLE NUTRITION

Like other fruit plants apple, for its growth, development, economic life, yields and better fruit quality is dependent on nutritive elements both of macro and micro ones. In the province of Punjab application of proper nutrition is not carried out according to the departmental recommendations. Consequently health and productive potential of our groves is being adversely affected.

FERTILIZER RECOMMENDATIONS:

A) RECOMMENDATIONS FOR MATURE ORCHARD

FYM/plant/year	Nitrogen /plant/year	Phosphorus /plant/year	Potassium /plant/year
35-50 kg	300 g	225g	225g
	Urea 0.652 kg Or Ammonium Sulphate 1.15 kg	TSP 0.48 kg Or SSP 1.25 kg	Pot. Sulphate 0.45Kg Or Pot. Chloride 0.37 Kg

- Fertilizer should be applied at least 1.5 feet away from the main stem up to one feet way from the canopy.

- The **FYM, Phosphorus** and **Potassium** in total should be applied during the end of December
 - First one third dose of Nitrogen should be applied during the third week of February. (Before flowering/sprouting). Also apply full dose of Potash and Phosphorus if these have not been applied during December.
 - Second one third dose of Nitrogen should be applied during the third/forth week of April. (When most of the fruits are pea size stage)
 - Third dose of Nitrogen should be applied during the last week of September. (After monsoon season)
- Every time the fertilizers should be well mixed in the soil, through light hoeing and followed by full dose irrigation.

METHOD OF APPLICATION:

During early three years fertilizer application is made under the canopy of the tree. After three year (in 4th year) fertilizer should be spread on the area under the canopy of plant leaving one foot area around the main stem. Mix the fertilizer by light hoeing. After application of the fertilizer irrigation is very important for up take of the nutrients by the plant

ERADICATION OF WEEDS:

Apple orchards should be kept free from weeds through hoeing and ploughing. Suitable Weedicides may be used with consultation of Agri. Experts. If weeds are not controlled, these will affect the production adversely by competing for nutrients with the plants. Weeds also serve an alternate host for diseases and insects.

PRUNING OF APPLES

Pruning is carried out to enhance establishment of a strong, well-balanced framework. Mechanically strong, well-balanced framework of branches constitutes good management practices. Pruning insure a balance between vegetative vigor and the fruitfulness also improve light penetration and increase the set of interior fruit. Apple requires judicial pruning.

- To maintain root/shoot ratio and develop the plant frame-work, pruning is done at the time of plantation and till the age of 3 years.
- Water shoots and undesirable branches should be removed regularly and should be a permanent feature in young orchards.
- Light pruning should be performed after fruit harvest for proper aeration and light transmittance throughout the tree canopy for better flowering and fruiting.
- Heavy pruning should be performed in Kaghzi lime with the special consideration to overcome the apical dominance and for better productivity and fruit quality.
- De-shooting of stock sprouts should be performed regularly.
- During pruning practice cut portions must be pasted with a suitable fungicide to prevent the disease and insect infestation.
- Removal of diseased, dried wood and water sprouts

Following are the benefits of pruning:

- Increase soluble solids contents and improve rind color.

- To force the tree to produce new and productive fruitwood.
- To treat orchards suffering from neglect or injury.
- Helpful in the treatment of diseases and recovery of trees.
- Where trees are tightly grown together, hedging may be employed.
- Benefits of spray operations by greater coverage.
- Limiting tree height may make picking easier and less expensive.

HARVESTING:

The apple fruit has very soft skin. So they are easily damaged while picking, packing and transportation from field to market and the end user, if not given due care. Therefore, apple must be picked, packed and transported very carefully. The fruit must not fall on the ground from the tree while picking. Picking should be done with the help of a scissor.

Packing must be done in wooden crates or mulberry accommodating from 10-12 kg of fruit only. It also demands care while loading, unloading and transportation from field to market and the end user.

PROBLEMS

SELECTION OF POLLINIZER:

Most apple varieties cannot set fruit unless their flowers are cross-pollinated with pollen of another compatible variety. Such varieties are called self-unfruitful. The lay out and number of pollinizer is an important part of orchard planning unless adequate pollinizers are there, the orchards remains unproductive and crop will be poor. 11, 15, 20, 25, 33 % pollinizers are being used in different parts of the world. In India 25 % pollinizers are being used.

QUALITIES OF A POLLINIZER:

For the selection of pollinizer bloom time of the pollinizer and the variety must be same. The variety should be diploid. The age and size of the pollinizer must be the same. The pollinizer must be regular annual bearer. The flowers of the pollinizer must be attractive for the bees.

HAIL STORMS:

In Murree hills late spring frost hailstorms are a serious threat for apple, which are very common from flowering to harvesting damaging 95% of crop. By the use of Nylon nets the hail storms affects can be minimized.

INSECTS AND PESTS OF APPLE:

1. Apple Lace Bug (*Stephanities pyrioides*)
2. Apple woody aphid, (*Eriosoma Lanigerum*)
3. Aphids, *Aphis* (*spiraeecola*)
4. San Jose Scale (*Quadraspidiotus perniciosus*)
5. Apple codling moth (*Cydia Pomonella*)
6. Tent caterpillar (*Malacosoma indicum*)
7. Mite (*Cenopalpus pulcher*)

DISEASES OF APPLE

1. Ripe rot (*rhizopus arrhizus*)
2. Powdery mildew (*podocphaera leucotricha*)
3. Sooty blotch (*gloeodes pomigena*)
4. Apple scab (*venturia inaequalis*)
5. Fire blight (*erwinia amylovora*)
6. Root rot (*phytophthora cactorum*)
7. White root rot (*Rosellinia necatrix*)