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Advancing Strawberry Cultivation Practices for Improved Yields and Sustainability in the Mid-Hills of Himachal Pradesh

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INTRODUCTION

The strawberry (*Fragaria* × *ananassa* Duch.) is one of the most important fruit crops in the world. It is the result of hybridization of two American octaploid species *F. chilonensis* and *F. virginiana*. It is a soft fruit belonging to the family Rosaceae and having chromosome number 2n=56 (Allo-octaploid). It is native from France. It is being cultivated in temperate regions but due to its wide range of environmental adaptations, it is also cultivated in sub-tropical and tropical climate. Botanically, it is an aggregate fruit that develops from the merger of several ovaries that were separated in a single flower that contain the seeds as achenes. The achenes are numerous, tiny, ellipsoid specks that cover the fruit surface. The edible portion of the fruit is fleshy thalamus. It is an attractive, luscious, tasty and nutritious fruit with a distinct and pleasant aroma and delicate flavor. The flavor of the fruit is due to the presence of volatile esters viz. Ethyl butyrate. It is a soft, delicate and a highly perishable fruit, often shipped in frozen condition in western countries. Due to its perishable nature, it should be operated carefully during transportation.

Strawberry is cultivated in many countries like Europe, Canada, and South America. In India, it is cultivated in Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Karnataka, Tamil Nadu, Rajasthan, Uttarakhand and Himachal Pradesh. In India, the total area and production of strawberry was about 1000 ha and 5000 MT respectively. In Himachal Pradesh, cultivated area of strawberry is about 500 ha with production of 500 MT. The climate of lower hills of Himachal Pradesh is most appropriate for better quality of fruit production, whereas the medium and high mountainous areas are very suitable for good quality of runner production. The different strawberry cultivars are well adapted to the different agro-climatic condition of District Sirmour, Himachal Pradesh.

Strawberries are mainly grown in temperate areas of Sirmour, which accounts for more than 90 percent of the total yield in the state. The farmers of district Sirmour are known for production of peaches, plums, apricots in the country, but during last few years, strawberry has caught the attention of large number of farmers in plain areas where it is being produced as a major cash crop. Due to good price and demand of Strawberry in the market, people are now taking keen interest in cultivation of Strawberry along with peaches, plums, apricots, which is becoming a source of good income for the farmers.

Importance and Uses:

Strawberry is a less calorific carbohydrate fruit and gives multiple health benefits after consumption of fresh fruits. It is rich in vitamin C (40-120 mg/100 g fruit), protein and different minerals like phosphorus, potassium, calcium and iron, fibre and also good source of high pectin content (0.55%) available in the form of calcium pectate. The fruits of strawberry have medicinal value and are considered for diarrhea, gout, stomachache and kidney stones, astringents, diuretics and mild laxatives. Most of the fruits are consumed fresh and having much demand in the fresh market as well as in processing industries and utilized in confectionery. Strawberry fruits are used to make various processed edible products such as juices, chutney, squash, jams and jellies milkshakes, pies, ice creams, and chocolates.

Climate and Soil:

Strawberry grows best in temperate climate but can be grown well in sub-tropical climate. It thrives well under agro-climatic condition of district Sirmour (Himachal Pradesh). Various climatic factors such as light, temperature have effect on growth and quality of fruit production. Moderate temperature and daylight period of 12 hours or less are important for the flower bud initiation. The optimum temperature for plant growth is about 15-26°C. Sandy loam soil rich in organic matter with pH 5.5-6.5 are best for the strawberry cultivation. High soil pH causes the poor formation of roots. In dry season moisture should be adequate for proper growth and better quality of fruits. Light soils and proper irrigation are considered best for the runner production.

Propagation:

Strawberry can be propagated through sexual and asexual means. Propagation by seeds is not suitable because the seedlings do not produce true to type plants. By asexual means it can be propagated through runners. In India, the propagation of strawberry through runners is mostly done in cooler climates of hills. The cooler climates of hills are best for the propagation of strawberry through runners. In plains, the runners are also produced but due to high temperature and humidity in summer, it is difficult to protect from diseases Viral diseases are transmitted by infected parent runners; therefore virus tested clonal material should be selected and planted in disease free area after soil sterilization. Early formed runners are preferred for planting because these are vigorous, have good root system and more productive. For nursery raising, sandy soils with irrigation facilities are preferred for good quality of runners production. Heavy soils should be avoided for runner production. The freshly dug runners should be best planted in nursery bed during early winter or spring. A single plant of strawberry can produce 12 to 18 runners. For maximum runner production, the inflorescence must be removed by hand pinching to prevent fruiting. Foliar spray of GA_3 at 50-100 ppm and N at 60-120 ppm increases runner production.

Land Preparation:

The soil is ploughed during summer with a soil turning plough which is followed by repeated ploughing to make soil friable, remove weeds and stubbles. FYM or other bulky manures should not be deeply ploughed because that works best when applied on the top soil. Soil fumigation with a mixture of methyl bromide (67%) and chloropicrin (37%)

helps to increase root system, reduce fertilizer requirement and control the weeds.

Planting: Planting can be done by hand in September to October. Use healthy and diseases free runners in hilly areas. Too early and too late planting results in poor quality of fruits and gives poor yield.

Systems of Planting: In cold climates matted rows planting system can be adopted. This is the simplest and least expensive method.

Figure1. Healthy runners for tranplantation

Popular Strawberry Varieties in India:

India has a diverse range of climatic conditions, making it suitable for cultivating several different strawberry varieties. The choice of variety depends largely on the region, soil type, and farming practices. Below are some popular strawberry varieties commonly grown in India:

Variety	Characteristics	Region
Chandler	Large, firm, sweet, and juicy berries	North India
Camarosa	Large, bright red berries with a sweet aroma	South India
Sweet Charlie	Medium-sized, bright red, and juicy berries	Western India
Pajaro	Large, firm, and flavorful berries	North-East India

It is crucial for farmers to select the appropriate variety for their region and growing conditions. For instance, Camarosa is best suited for the hilly areas of South India, while Chandler is more suitable for the plains of North India. The success of a strawberry farm also depends on factors such as seed quality, soil fertility, and irrigation practices.

Hybrids and Imported Varieties:

Aside from the four varieties mentioned above, there are also other strawberry hybrids and imported species that Indian farmers can choose from, such as Sequoia, Festival, and Albion. These varieties are known for their high yields, faster growth, and disease-resistance. However, their suitability to Indian conditions may still be a matter of experimentation.

The choice of variety also depends on market demand and consumer preference. Farmers may opt for varieties that are in high demand, such as Chandler or Camarosa, which are popular in the domestic market. Alternatively, they may choose to grow newer varieties, such as Albion or San Andreas that have a longer shelf life and are suitable for processed products.

Irrigation:

Strawberry plants require consistent and adequate water supply, especially during flowering and fruiting. Use drip irrigation or sprinkler systems to avoid excess moisture on

the foliage and prevent disease. Avoid overwatering or under watering, which can affect plant growth and fruit quality.

Fertilization:

Regular fertilization is necessary to provide the essential nutrients required for healthy plant growth and fruit development. Use balanced fertilizers and follow recommended rates and schedules. Avoid over-fertilization, as it can lead to excessive vegetative growth and poor fruit quality.

Mulching:

Mulching the strawberry field is very useful practice as it helps in conservation of soil moisture; checks weed growth and avoid the direct contact of berries with soil. Both organic and inorganic mulches are used in cultivation of strawberries. Mulches reduce the percentage of spoiled fruits and prevent the infection due to fruit root. Before mulching, the soil should be dusted with insecticide for protection against insects. Strawberry beds can be mulched with pine needles, grain straw or saw dust. Black polythene mulch increase temperature of the soil and also soil moisture during summer.

Protected Cultivation:

The commercial production of strawberry using the plasticulture system is becoming popular with the growers. Protected cultivation of strawberry in plastic tunnels, green houses and glass house structure is meant for early production of fruits. The plants under these structures flower one to one and half month earlier than the unprotected plants and produce ripe fruits earlier than those available from open cultivation. Plastic films of 150 mm can be used and kept for two years. Ventilation is provided to avoid excessive heat and to avoid development of malformed fruits.

Chandler variety is most suitable for growing in protected structures and produced best quality fruits. In plasticulture system, the raised beds are formed each year, fumigated and covered with plastic to prevent weed growth and erosion. Plants are planted through holes punched in this covering.

Use of plastic tunnels in Chandler cultivar enhanced earliness in fruit ripening and produced higher yield. Low tunnels of 50 cm height with transparent polythene film of 50 micron with the help of G1 wires can be installed in winter months from December to February to protect the plants from cold. Tunnels should be opened during day time for maintaining high temperature inside for early flowering and better fruit yield.

Figure 2. View of strawberry field under protected cultivation

Harvesting and Handling of Fruit:

The fruits are harvested along with the caps still attached and with their stalks when 50 percent of the surface has attained red colour. The fruits harvested at 75 per cent red colour, develop full red colour within 1-2 days at 21°C temperature. For sending to longer distant market, berries are harvested immediately after reaching full colour. For processing purpose, fruits are picked firm ripe

with one to two third of the surface showing colour. For local markets, fruits are picked with cap and stem of about 12 mm length. Strawberries are allowed to ripen on the plant fully as they do not continue to ripen after harvest.

Strawberries do not mature uniformly, as such harvesting should be completed in many pickings. The fruits should be picked up daily in warm weather and 2-3 times a week under cold conditions. Picking operation should be completed before noon to avoid heating to berries. Picking should be done in the early hours to avoid spoilage during transportation and storage. After harvest, fruits should be kept under shade to avoid damage due to excessive heat in the open field. The strawberry fruits decay within 2-3 days of harvesting under natural conditions.

Challenges and Risk in Strawberry Farming:

Challenge/Risk	Description	Management Strategy
Weather fluctuations	Unpredictable weather patterns, including heavy rain, hail, frost, and heat waves, can damage crops and reduce yields.	Monitoring weather forecasts and implementing protective measures such as nets, mulching, and irrigation.
Diseases and pests	Common diseases and pests that affect strawberry plants include powdery mildew, botrytis, spider mites, thrips, and aphids.	Applying appropriate fungicides and pesticides, practicing crop rotation, and using natural predators for pest control.
Marketing volatility	Market prices for strawberries can be volatile, with fluctuations in demand and supply affecting profits.	Establishing direct sales channels, understanding market trends, and identifying target markets to reduce dependence on middlemen.

Disorders:

Albinism is a physiological disorder in the fruit of strawberry. Disorder occurred due to lack of fruit colour during ripening. Probably, this disorder is caused by certain climatic conditions and nutrition excess. Fruit remain white or irregularly pink and swollen in certain cases. The fruits become less firm and have acid taste. Such fruits often damaged during harvesting, become susceptible to Botrytis and decayed during storage.

CONCLUSION

Strawberry farming in India has come a long way and is now a booming industry in the country. With favorable climate and soil conditions, farmers have been able to grow a wide variety of strawberries and meet the growing market demand for the fruit. Through the challenges faced in strawberry farming, farmers have been able to overcome them through their dedication, hard work, and government support. The industry is growing, and with the implementation of sustainable practices, it is set for even more growth in the future. Aspiring strawberry farmers can take advantage of government support, training programs, and infrastructure development to start their own strawberry farms and contribute to the success story of the industry. It is imperative that farmers continue to adopt best practices, embrace sustainability, and explore the potential of organic farming to ensure long-term success in the industry. With such a bright future ahead, the strawberry farming industry is undoubtedly a sweet success for India.