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Ankita Aman
Department of Fruit and Fruit Technology, BAU, Sabour, Bihar, India

Suparna Sinha
Department of Fruit and Fruit Technology, BAU, Sabour, Bihar, India

Rajni Rajan
Department of Fruit and Fruit Technology, BAU, Sabour, Bihar, India

Correspondence
Ankita Aman
Department of Fruit and Fruit Technology, BAU, Sabour, Bihar, India

Potentiality of protected cultivation in fruit crops: An overview

Ankita Aman, Suparna Sinha and Rajni Rajan

Abstract
Protected fruit cultivation has developed very quickly and widely and now it has become an important branch in fruit cultivation. It enables some control of wind velocity, moisture, temperature, mineral nutrients, light intensity, and atmospheric composition and has contributed and will continue to contribute much to a better understanding of growth factor requirements and inputs for improving crop productivity. A brief introduction, various structures of protected cultivation, characteristics of fruit crops for the protected cultivation and other information are summarised here.

Keywords: protected cultivation, greenhouse, windbreak, tunnels, fruit crops

Introduction

A technique of protecting plants from adverse biotic and abiotic stresses and providing favourable environmental or growth conditions to the plants. With the advancement in agriculture various types of protected cultivation practices suitable for a specific type of agro-climatic zone has emerged. Protected cultivation is a specialized form of agriculture. The purpose of protected cultivation is to grow crops by altering the natural environment of the crop so that the harvest period can be extended. The benefits of such systems includes easier cultivation (e.g., irrigation, weed control, pest management, harvest), decrease in yield lost by ecological factors, working in all weather conditions, enhancement in marketable fruits, consistent high yield, and most important, earliness and higher profitability. It also increase the yield, improve the quality and stability of production and make commodities available when there is no outdoor production. Its primary emphasis is on production of high-value horticultural crops. It provides control over wind velocities, moisture, temperature, mineral nutrients etc. It is expected that the area under protected cultivation may accentuate to about 84.2% for the period from 2013-17. Various kinds of fruit, such as strawberry, grape, peach, nectarine, flat peach, apricot, cherry (including Chinese sweet cherry and mazzard cherry), plum and citrus, have proved to be successful for protected cultivation in China. In China Strawberry cover the largest planted area, about 70% of the total production and then grape, peach and nectarine.

Among the greatest constraints in fruit crop production are lack of sunlight, fluctuation in temperature, lack of moisture or excess, weed growth, wind velocity and atmospheric carbon dioxide. These all constraints are related to the climatic factors directly or indirectly and have been reduced by protected cultivation. There is need of protected cultivation for the quality enhancement, to increase the yield, off season cultivation, better insect and disease control, to use the resources efficiently. Protected cultivation has significant role in round the year plant multiplication, improving quality and yield, increases harvesting span, rootstock production, and enhancing vegetative and reproductive growth. Various protected cultivation technologies includes greenhouse, nethouse, shadehouse, windbreaks, High and low tunnels, Earth Tube Heat Exchanger (ETHE) for hot humid areas, mulching, Bagging/fruit covering.

Management of the environment for the protected cultivation

Humidity and Temperature: Temperature can be managed and controlled by lowering the temperature on sunny days and heat conservation on cloudy and rainy days. For lowering the temperature, ventilating pit can be opened and heat preservation materials (such as straw quilt), thickening walls, digging winter protection ditch and artificial heating can be used for the covering and maintaining the heat. To meet the chilling requirements of some varieties, there is a need to cover the house with a straw quilt during the day and to open at night. As the ground temperature is always lower than air temperature in the greenhouse, so mulching can be done with black or colourless plastic film 20 to 30 days before heat conservation method to raise earth temperature begins. Film mulching and irrigation are practices adopted to lower the

humidity in the greenhouse. Developmental stage and types of species determine the temperature and humidity requirements of the crop.

Light: Usually 60-70% light intensity is maintained inside the greenhouse to that of outside. Various techniques such as using hydrophobic film having good light penetration properties, hanging reflecting film, mulching reflecting film and adding artificial light can be used to increase the scatterdness of the light.

CO_2: The CO_2 concentration is much lower inside the greenhouse to that of outside. In order to enhance photosynthesis rate and production of fruits having good quality, techniques such as using CO_2-releasing fertilizer and applying well-rotted manure can be used.

Characters of fruit crops for protected cultivation

Fruit plant should be rapid grower like papaya, banana and strawberries. It should have dwarf characters and show good response to training and pruning. Single stemmed fruit crops is suitable for the protected cultivation. The varieties selected should be regular bearer with high yield. It should also free from biotic and abiotic stress. Short duration and early varieties should be selected for the cultivation. The various structure under protected cultivation are discussed.

Greenhouse

Greenhouse was first introduced in India during 1960s for research purpose and commercial cultivation started in 1988. It is a framed structure covered with UV stabilized plastic films in which crops are grown under partially or fully controlled environments.It ensures production at any place at any time. Covering materials can be glass, Polyethene film, rigid panel and shading net. Growing systems are raised beds, ground beds, benches and pots. Papaya, strawberry, peach, citrus etc. are grown under greenhouse. Various types of green houses are Rigid frame, A-frame, Quonset, Gothic, Post and rafter etc. It is location specific. In plains N-S direction so that longer sides avoid sun scorching. In hills S/ S-W/ S-E direction for maximum utilization of sunlight. Galan Saucov *et al*. (1992) [13] studied the influence of environmental modification (greenhouse versus open air) and aspect (north versus south slope) on morphology of banana cultivar dwarf Cavendish in the canary islands. It was found that plants grown under greenhouse were superior in plant height, bunch mass and yield as compared to open field condition grown plants. Further Casierra-Posada *et al*. (2011) [4] studied the basic growth analysis in strawberry plants exposed to different radiation environment. Plants were grown in greenhouse in Columbia under different light quantity regimes provided by polypropylene films (yellow, green, blue, transparent, red, a control without plastic film cover). They observed that root to shoot ratio of plants under green cover presented significantly higher value (88.77%) as compared to control plants with no cover. All other cover showed no significant difference with the control treatment. Santos *et al*. (2008) [11] studied the growth of seedlings of papaya and passion fruit in protected cultivation and it was observed that the height of papaya plants does not differ at 31 DAS, however from the collection made 38 DAS is of greater heights in environment A2 (screened with monofilament mesh) and A3 (screened with mesh aluminizada) and that trend continued till the plant reaches the age for plantation. Thus shading effect promotes a lower evaporation in the environment in addition to the reduction in transpiration from the plant, allowing it a condition more conducive to development. Schettini *et al*. (2011) [14] studied the influence of two photoselective and three photoluminescent greenhouse plastic films on the growth of cherry and peach trees in the field and in laboratory. They found that significant increase in o shoot growth in peach and cherry trees using plastic films that modify the spectral distribution of solar radiation.

Nethouse and Shadehouse

Net house is naturally ventilated and climate controlled. Shade houses are structures enclosed by agro-nets or any other woven material to allow required sunlight, moisture and air to pass through the gaps. These are used to reduce adverse effect of scorching sun and rains. They are used to produce graft saplings and prevent its mortality. Also used in quality drying of various agro products. Grapes, citrus etc. are grown under it. Tyagi *et al*. (2015) [15] studied the plants of five cultivars of papaya to evaluate yield and various physico chemical traits under poly net house. The study revealed that among 5 varieties, the harvesting was earliest in Red Lady 786, which took least no. of days (295) while fruits of Arka Prabhat took least no. of days (388) to harvest. Kaur *et al*. (2017) [5] investigated the performance of papaya cultivar Red Lady 786 under protected and open condition and revealed that the plants under net house showed an increase in the vegetative growth, flowering, fruiting and yield parameters of papaya with maximum height of plants (214.05 cm), number of leaves per plant (20.46), leaf area (876.5 cm2), number of hermaphrodite flowers per plant (51.32), fruits per plant (49.52) and yield (45.39 kg/plant) respectively.

Windbreak

It is a device designed to obstruct wind flow and protect against any ill effect of wind and it also reduce the surface wind speed due to which there is change in microclimate, resulting in an increase in air temperature during the day and a reduction at night. It enhaces early maturity, improve growth, increase production and result in a better quality product and reduces photosynthetic activity and increases evapo-transpiration. The optimum distance between windbreaks of the permeable type is 15 to 25 times the height. It can be natural or artificial. Natural windbreaks are Eucalyptus, Cypress, Casuarina, Poplar, oak and some conifers. It can be artificially prepared by the remaining part of vegetation or from manufactured materials.

Tunnels

A long, half cylindrical enclosure used to protect plants, made of clear plastic stretched over hoops. Types of tunnels are low tunnels and high tunnels. Low tunnels are small structures that provide temporary crop protection. Their height is generally 1m or less. Their use enhances early and total yields and they offer protection against unfavorable climatic variables. Thermal films of infrared PE, EVA, copolymer, polyvinylchloride (PVC), and conventional PE are being used worldwide. High tunnels are protective structures tall enough that are used to lengthen the production and marketing season of the crop. There is no use of artificial cooling/heating or ventilation system. Mostly covered with single or double layer of polyethylene plastic and it has life of near 20 years. It is very useful in absorbing radiant energy to increase air and soil temperature. In temperate parts of the world, these are used to extend the growing season by creating a warmer environment inside. Ambad *et al*. (2007) [2] studied the

growth, yield and quality of strawberry (Fragaria x ananassa Duch.) cv. Chandler as influenced by various mulching materials. He used four treatments LTM (Low tunnel with Mulch), LTWM (Low Tunnel without Mulch), OFM (Open Field with Mulch), OFWM (Open Field without Mulch). It was found that cultivar grown under LTM has vigorous growth and took 57 days to 50% flowering. No. of fruits/plant, average size of fruit, weight of fruit were maximum of the plants grown under LTM.

Mulching

It is the application of a protective covering, usually of organic matter such as leaves, straw or peat placed around the plants. It provides a favourable environment for growth which results in more vigorous, healthier plant which may be more resistant to pest injury. Mulching prevents evaporation of water from the soil surface and also reduces the weed growth. Mulches can be inorganic or organic. It has various effects on the soil like it reduces infiltration rate, conserve soil moisture, maintains soil temperature, reduces fertilizers leaching. It Promote early harvest of crop and improve yield and fruit quality. Bakshi *et al*. (2014) [3] studied the effect of mulching on physical parameter and yield of strawberry. The average fruit weight was influenced by different mulch material with the maximum average fruit weight recorded in black polythene mulch followed by transparent mulch. Fruit length, breadth as well as yield was found significantly higher under polythene mulch than other treatments. This is due to the weed free environment provided by black polythene mulch.

Other ways of protected cultivation

Fruit cracking can be prevented by using physical and chemical methods. In 2008 fruit cracking was averaged to 24.6%. Meland *et al.* (2014) [7] found that two application of 1% Biofilm reduced the average fruit cracking to 17% in sweetheart cherries and further inclusion of a preharvest fungicide (Fenhexamid) in combination with plastic ground covers reduced fruit cracking to 9.8%. In Norway retractable plastic rain covers and multi bay polyethylene “high tunnels” system have been researched. Biforsk three-wire system consists of a main frame with wooden poles supporting three overhead wires at 4m. The polythene cover is gabled around the centre axis. Woven polyethylene sheets are used as curtain. Multiday polyethylene tunnels comprised of galvanized metal. Bags were covered with polyethylene, but left open for ventilation. Bunch covering/bagging provides protection of fruit crop against pathogen, wind damage, dust, sun burn, bird feeding etc. It also improve yield and fruit quality. It is generally translucent or blue covered. Rajan *et al*. (2017) [9] studied the effect of sleeving on post shooting bunch spray of chemicals banana cv. Grand Naine. They covered the banana bunch with blue polythene sleeves of 50 micron sprayed with chemicals and found significant result on yield, bunch characters and economics on banana. Rajan *et al*. (2017) [10] found the 50 micron sleeving with chemical treatment on maturity and quality of banana cv. Grand Naine. They found the advance maturity and increase the quality characters like TSS, reducing and total sugar and shelf life of banana. Amani and Avagyan (2014**)** [1] studied the effect of polyethylene bunch cover on fungal disease control in banana crop. Protection of young bunches with polyethylene bag covering were taken 2-3 weeks after formation of fruits. Infection incidence of disease in two treatments (20 bunches with cover and 20 bunches without cover) was detected. Result showed that the symptoms of pitting, tip end rot and cigar end rot were observed in the bunch without cover. At the end crop of each plot were harvested and length, weight (bunches), hands and fingers were measured. Finally, using polyethylene cover is recommended treatments for decreasing of disease damage and improving the quality characters of fruits. Muchui *et al.* (2010) [8] found that the banana cover did not influence green and shelf life significantly. The cover used in the study were perforated and translucent and hence did modify the atmosphere considerably to affect green and shelf life of fruit. It was also observed that bagged fruits in the experiment had minimal bruises (2-5%) and were significantly cleaner from dust, spider webs and bird droppings at harvest as compared to unbagged fruits (50%). Top hands were affected especially those of bunches covered with dull blue covers probably due to more heat absorbed inside the cover compared to the shiny blue covers which may have reflected some heat away. Santosh *et al*. (2008) [12] studied the effect of change in height of banana cultivars seedling under protected environment. Seedlings were planted in polyethylene bags (15x25 cm) in a nursery screen house with substrates (vermiculite, soil etc.). They observed not huge variations in growth from second to ninth weeks for all cultivars of this work, but the cultivar Tropical showed stronger growth in relation to other cultivars between eighth and ninth weeks. Thus, the polyethylene bags filled with substrate were adequate to promote uniform and satisfactory growth of seedlings.

Some miscellaneous techniques of protection

Protection by Straw: Papaya is very sensitive to frost due its broad leaves and succulent stems. Covering the plants with thatches and straw prevents damage from frost and thus improves yield and quality.

Use of polyethylene cover for grape shading and drying

Nursery management under protected cultivation: Protected environments provide congenial condition for growth of propagating materials. It makes round the year production.

Maintenance of in-vitro raised cultures under protected cultivation: In-vitro raised cultures are grown in greenhouse/ shade for hardening and acclimatization to protect cultures from external damage.

Limitation

High cost of initial installation, non-availability of various components, need of skilled labour, needs a special postharvest facilities.

Conclusion

Protected cultivation is developing very quickly and becoming profitable day by day for the growers. It is beneficial for producing quality production for export. Strawberry, grape and nectarine are the three main crop of which strawberry contribute large proportion in it. Protected cultivation production system offers great scope to produce organic fruit, minimize insect pest incidence, avoid fruit cracking, and prevent frost injury, hardening of tissue culture as well as cut, budded, layered and grafted plants. Lack of local varieties suited for growing under protected structures then breeding of specific varieties is must. Production technology of each crop under protected condition should be standardized. There is a need for the further research in other fruit crops regarding protected cultivation. As the quality

parameters of the crop grown in protected cultivation is often better than field condition. Also there is a need to focus on the improvement in the structures, growing techniques and physiological studies of the plants to enhance the quality of the fruit crops.

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