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Advanced and modern fruit production techniques: A review

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Abstract
The objective of the current review is to identify the research work done in case of advance and modern fruit production techniques. Many new techniques are adopted in the field of horticulture for producing better quality fruits. These techniques include soilless culture of fruit crops i.e. aeroponics, meadow orcharding system and high density plantation, use of advance and modern intelligent information techniques. Soilless cultivation is possible with hydroponics and aeroponics. Cultivation of strawberry by aeroponics technique is much more advanced and helps in the year round production of high quality fruits but under protected structures. This reduces the labour for production of strawberry in soil and adds the benefit of easy production of nutrient rich fruits without chemical residue from soil and management of fungal diseases. Meadow orcharding is already practiced globally. It has got more attention recently among growers due to higher production and efficient use of drip irrigation and fertigation. Meadow system of orcharding is followed mainly in peach and guava. Reason for adopting modern technique of meadow planting includes better utilization of resources, efficient management of fruits in every steps leading to proper knowledge of fruit trees, accommodation of large number of trees thereby higher production and return as output. Many automatic machines are being operated in the fields for successful management by preprogramming. This paper gives a light into worthwhile, new advanced and modern techniques in fruit production.

Keywords: Intelligent automated system, Aeroponics, orchard monitoring, meadow planting

Introduction
Fruit crops are cultivated for long time ago, commercially as well as non-commercial, non-specialist gardens. A large number of trees shrubs, and perennials that are non woody in nature includes the subjects in programmes of germplasm improvement. Production of fruit crops includes cultivation of perennial plants which produce fruits having economic importance Brennan and Millam, (2003) [3]. Perennial nature, high heterozygosity, clonal propagation from elite mother plant are the common characteristics of fruit crops. Increase in the yield of fruit crops are greatly influenced by the improvements in technology along with unification of the fruit and nut industries in the most favored climates of the world. Now a day fruit is is progressively perceived as as a vital part of a good eating routine, and intake of fruit and its products, particularly juices as well as fruit products added with dairy farm subsidiaries, has up pointedly over the previous decade Childers, (2019) [4].

Production of fruit crops accelerated in the past decade with the advancement in fruit cultivation techniques including modern methods. Modern method of fruit production begins with use of advance technique in preparation of land using different sensors in tractors. Soilless cultivation of fruit crops is advancing with the use of hydroponics and aeroponics. Among these techniques aeroponics is a recent approach used to cultivate fruit crops. This novel method of fruit cultivation is reviewed as best method of growing plant for sustainable development due to its efficiency and food security and as well as economics (Lakhiar *et al*., 2018) [23]. Planting system helps the growers in effective management of fruits and maximum utilization of resources in the orchard (Lakso, 1996) [22]. Meadow orcharding is a widely accepted concept of ultra-high density planting of fruits (Sharma and Mursaleen, 2014). High density planting is gaining more momentum in cultivation of fruit plants for better economic return and management of plants. Management of orchard is a considered as a difficult task because of large number of plants with different especially huge size. Dwarfing rootstocks is a promising solution at this point but still it is difficult to manage a big orchard. Technology for identifying plant diseases, determining chlorophyll and nitrogen content is offering a positive solution for the management of large number of plants in the fruit orchard.

Thanks to information technology as it is providing data and helping the fruit industry aimed at commercial production of crops (Ellis, 2010) [9]. Advance techniques enabled successful dry land fruit cultivation in different parts of the world. Pruning and training, mass production and application of bio agents in the field, adaptation of advance approaches in integrated pest management and high tech. cultivation enabled the fruit growers to earn profit from fruit farming (Ranpise and Musmade, 2017) [35]. Some of the modern fruit growing techniques helped in enhancing sustainability and therefore it increased the dependence of grower on purchased inputs for crops (Merwin and Pritts, 1993) [31]. Hence this review paper gives an insight into advance and modern fruit production techniques required for present and future needs.

Advance and modern techniques for preparing land and soilless cultivation in fruit production

Holpp and Durr, (2006) [17] reported concerning development of system with distance sensors, steering angle sensing element, steering drive, software controller and remote control as the parts for using in fruit farming jobs. Some machines especially tractors sometimes got to be compelled to be steered in a very definite line and on rows and wishes a high degree of concentration which frequently leaves no capability for the checking of tractor-mounted implements and crops. It was mentioned that automatic steering systems reduce driver stress and allow loads of relaxed operative and an additional economical use of machines and resources for making a fruit framing work. Soilless culture in modern agriculture includes technique of aeroponics. Lakkireddy *et al*., (2018) [24] described aeroponics as a modern practice used in soilless cultivation for commercial food production. The technology of aeroponics assumes a pivotal part in twenty first century in soilless culture in industrial food generation. In this innovation natural media is used to develop the plants. The most important rule including the employment of sprayers, nebulizers, foggers to form a fine mist droplets for delivering nutrients to plants roots (Christie and Nichols, 2003) [7]. Use of sprayer facilitates better nutrition for plants in aeroponics, thereby disease is prevented and growth is stimulated which ensures high yields. The high yield of plants grown under aeroponics is due to adequate supply of oxygen and water which is a limiting factor for growth in conventional systems (Christie, 2003) [7]. Jun *et al*., (2008) [19] led a test to contemplate lower root zone temperature effect on growth of root and shoot in aeroponics. The investigation was done by growing Akihime' strawberries in aeroponics in cold season. They observed that decrease in root zone temperature resulted in decreased root growth, mainly in lateral roots of strawberry. At 18∘C temperature in root zone, highest elongation of main roots was reported, whereas root zone temperature of 8∘C had lowest number of lateral roots and length of lateral roots. Temperature in the lower zone of root resulted significantly in decrease of root and shoots fresh weight, leaf area of strawberry, leaf length, leaf width and number of leaves of strawberry. They concluded that these temperatures should be avoided below the root zone of aeroponics cultivated strawberry. Kanechi *et al*., (2015) [20] developed a new aeroponics mechanisim with spray fertigation to use throughout the late spring by using dry-fog method for strawberry which is ever bearing. This technique involves the sprays of nutrient solution as very fine fog near the root zone with a normal drop distance across of not exactly 10 μm. They cultivated strawberry plants with dry-fog aeroponic system and compared formation of flower bud, quality of fruits, photosynthetic rates just as chlorophyll content what's more, absolute solvent protein in leaves with those of plants developed by trickle fertigation with palm shell medium as a control. The inflorescence number and °brix fruits increased significantly in dry-fog aeroponics, however, the quantity of runners and vegetative development essentially diminished in comparison with control. From the findings they concluded that this modern technique is potential for soilless cultivation of strawberry fruit production. Treftz, (2015) [41] compared sensory and nutritional qualities of hydroponic and soil-grown raspberries and strawberries by conducting various experiments. The outcomes from their trial examines suggest that hydroponics is ready to help in sustainable food production by providing equally nutritional and tasty food. The hydroponic raspberries and strawberry results showed a better return, equivalent or best nutritional quality, and same or best in taste inclinations contrasted with soil-developed raspberries and strawberries. From a study by Lee *et al*., (2015) [26], influence of various concentrations of nutrients is revealed for summer strawberry cultivar's growth and yield which is cultivated in a hydroponic system. They hydroponically grown 'Albion' and 'Goha' strawberry in four nutrient concentrations with electrical conductivity (EC) of 0.5, 1.0, 1.5, and 2.0 $dS \cdot m^{-1}$. The nutrient solution with an EC of 1.0 $dS \cdot m^{-1}$ resulted in noticeable growth of shoot dry weight and plant height in Albion' and 'Goha' strawberry cultivars. From the study they reach to a point that the best supplement arrangement strength for overall production of 'Albion' and 'Goha' strawberries is 1.0 $dS \cdot m^{-1}$. Mattner *et al*., (2017) [30] evaluated and reviewed strawberry transplant production by using soil-less system. They concluded that these systems are more exorbitant than exposed established runner creation but help to avoid usage of chemicals for soil disinfestation. Also these advancements have the best potential for application within the early ages of runner increase, and should help with diminishing the amount of generations required to supply certified runners.

Table 1: Peculiarity of advance and modern technique in land preparation and soilless cultivation in fruit production

Serial No.	Technique	Crop	Peculiarity	References
1.	Hydroponics: nutrient film hydroponic system (NFT)	Strawberry	Similar plant growth under different concentration of nitrogen, potassium, calcium	Chow *et al*., (2002) [6]
2.	Subsoiler drawn by walking tractor	Apple	soil bulk density decreased; improvement in soil porosity; enhancement in soil water content in soil, soil organic matter and soil total nitrogen	Gao *et al*., (2010) [13]
3.	Autonomous tractor	Plantation crops	self-ruling route framework to decrease vehicle's sensor cost	Thanpattranon et al., (2015) [34]
4.	Aeroponics: tropical greenhouse condition	Strawberry	Ground heat exchanger for root-zone cooling on the development and yield.	Pascual *et al*., 2019 [33]

Advance and modern techniques of meadow orcharding for planting in fruit production

Meadow orcharding in fruit crops were reported very early by different research scholars. Erez (1976) [10] reported that Sunred peach was filled in a glade plantation framework with 19,000 plants per hectare. He observed that fruit bearing was very early in this planting system. He also mentioned the use of paclobutrazol for dwarfing the trees (Erez, 1984) [12] and growth control in meadow orcharding system (Erez, 1986). Costa and Testolin (1993) [8] gave an early description that peach and nectarine meadow orchard was highly suitable for temperate climate. They tested different levels of planting density 1x1 m, 1x2, 1x4 and 2x4 m spacings. The found that only the "annual-bearing system" with a spacing of 1x1 m reached a satisfactory production among the tested meadow orchard systems. There are advancement in this technique in modern times due to wide application of fertigation and better pruning and training practices using machines. Robinson, (2004) [36] noted that for apple, pear, peach, cherry, apricot and plums, planting density have increased due to development of improved management systems. The major improvements that contributed to tree density are less pruning strategy improvement, development of feathered tree, limb angle approaches. Singh (2010) [38] reported about meadow orchard development in guava for higher production. Central institute of Subtropical Horticulture, Lucknow investigated the meadow orchard system, a new concept of guava planting. It was reported that Allahabad Safeda trees of guava can be planted at a distance of 1.0m ×2.0m which gives a density of 5000 tree/ha. This system is intended to provide fruit from 1st year and controlled to provide an easier and smaller structured framework instead of ancient huge and well branched trees. Induction of fruit buds in guava from the first year is done by topping and hedging of the plant and also this process helps in minimization of tree canopy dimension. Flowering of trees and fruit bearing took place in the first year of planting. In the first year, an average yield of 12.5 t/ha was obtained whereas after five years, an estimated yield of 50 t/ha was obtained of planting in the meadow orchard system. In order to understand efficient fertilizer use, status of nutrients in leaves, yield and quality of guava cv. 'Shweta', drip irrigation was scheduled under the meadow orcharding by Kaushik *et al*., (2013) [21]. They have made treatment combinations as [(basin (I_0), 50% (I_1), 75% (I_2), and 100% (I_3) water system of irrigation water/aggregate pan evaporation] and four fertigation as [basal dose (F_0), 50% (F_1), 75% (F_2) and 100% (F_3) fertilizer which is water soluble]. They tracked down that 75% irrigation of water system water/aggregate container vanishing +75 % fertilizer which is water soluble through drip method resulted in quality fruits with maximum yield of (32.79 t/ha), and highest net return. This study reveals that meadow orcharding is efficient in resource utilization with above said percent of irrigation. Choudary *et al*., (2015) [5] also mentioned about high density and meadow orcharding as a new technique of fruit cultivation which include dense planting of fruit trees, permitting little or short trees with overhang which is modified for higher light capture and conveyance and simple motorized field activity. HDP and meadow orcharding provides higher yield because of increase in the no. of trees/unit area which leads to more returns/unit area. This was made conceivable by customary pruning and utilization of bio controllers for keeping up with the size and form of the tree. Singh *et al*., (2015) [39] conducted a field investigation to further develop yield and nature of guava under mulching with polyethylene and use of drip irrigation method under meadow orchard. Allahabad safeda was grown and four level of irrigation with pan evaporation replenishment 40%, 60%, 80% and 100% and one ring basin irrigation method as control. Under the application of irrigation at 80% pan evaporation, more number of fruits (27.3), higher fruit weight (107.3 g) and yield of fruit (16.92 kg m−3) were recorded. Trickle water system along with polyethylene mulching resulted in superior quality of fruits with increased TSS with 12.1°Brix, total sugars of 6.61%, ascorbic acid at 169.2 mg 100 g−1 and reduced acidity of 0.27% in comparison to the control having minimum TSS of 10.1°Brix, total sugars with 6.12%, ascorbic acid at 159.6 mg/100 g and expanded acidity of 0.34%. This lead to a conclusion that drip irrigation is more effective to improve yield and nature of guava cv. Allahabad safeda under glade orcharding. Hariom and Shant (2015) [16] worked on an experiment in meadow orchard to show the effectiveness of shoot pruning on plan development, blossoming and yield in guava cv. 'gasp prabhat't. They pruned the half of the shoot of guava tree during month of April and July. They recorded that 50% of pruning vegetative growth of plant leading to emergence of new shoots. Pruning of half shoots in April resulted in better fruit weight during winter season. Lowest yield was in un-pruned control in winter time (1.24kg/plant).

Advance and modern techniques for orchard management in fruit production

Details of 'VCHERRY' called as Virtual Cherry tree is a type of interactive computer model developed for growth and cropping of sweet cherry given by Lang (2005) [25]. This model helps in making prediction about the tree, yield and quality reacts to make decisions for orchard management through predictions of leaf area, interception of light, yield and quality of fruit. 'VCHERRY' also uses computer animations to show the development of canopy and crop progress under completely diverse info boundaries, similar to rootstock genotype and pruning techniques, giving evaluations of quick and plausible semi-perpetual effects of annual plantation management choices. Guo *et al*., (2015) [15] projected hyper spectral imaging technology to spot the healthy and pathogen affected diseased leaves like infected with citrus tristeza virus. They have collected hyper spectral coefficient of reflection pictures showing healthy and morbid leaves infected with completely different isolates of citrus tristeza virus as well as TRL514, CT30, CT32 and CT11A within the visible and near-infrared region of 400–1000 nm. Liu *et al*., (2015) [27] used surface-enhanced Raman spectrographic analysis for phosmet residues detecting sweet orange (navel) surfaces. The investigation led was directed to recognize and describe phosmet pesticides extricated from the navel orange surfaces. Detection was based on surface upgraded Raman spectroscopy using silver colloid and substances like Klarite. From their study by using silver colloid they procured Enhanced Raman signs of phosmet over a fixation scope of 5 to 30 mg/L. The results with Residual Pesticide of 0.963, furthermore, root mean square blunder of forecast (RMSEP) 6.424 mg/L showed that surface-enhanced Raman spectrographic analysis may be a potential tool for phosmet chemical residues analysis. Wu *et al*., (2015) [43] developed nitrogen parameter detector which was based on spectroscopy to access the nitrogen content of jujube tree inside the plantation. It was equipped with one management unit and multiple sensing element nodes for measurement.

The sensor hubs were utilized to quantify jujube tree plant's reflectance on the canopy at the 550, 650, 766 and 850 nm wavebands respectively. This is then calibrated and further calculations were done. This instrument provides a new non-destructive method for monitoring the nitrogen parameter in the orchard. Assessment of chlorophyll content in the leaves of youthful apple trees utilizing hyper spectral technology is developed by Wang *et al*., (2015) [42] and they established various estimated models by using sensitive parameters. The partial least sq. model has the best determination constant (R2), lower root mean error (i.e., RMSE) and relative error p.c. This model is best fitted for estimating the chlorophyll content of young tree leaves. An optical detector for rapid detection of chlorophyll and nitrogen concentration in apple tree leaves to suit the real need for orchard growth was introduced by Zhang *et al*., (2015) [45]. In combination with the first reflectance and relationship bends, four groups of 550nm, 640nm, 680nm and 780nm are discovered having ability to explain the concentrations of chlorophyll and nitrogen in the leaves photoreaction stage, which can be utilized as touchy groups to anticipate the content of chlorophyll and nitrogen. Lyu *et al*., (2015) [29] developed a new technology for Newhall navel oranges filled in seven origins in China to predict soluble solids content using spectroscopy. Samples from different origins of Newhall navel orange was collected as seven groups. Various developing conditions caused the variety of SSC of oranges. The halfway factual method relapse (PLS) models were applied to foresee the SSC of its starting point tests and distinctive beginning examples. The outcomes prognosticated by beginning model were the least difficult contrasted with cross-beginning expectation results. The overall results showed that SSC (soluble solids content) forecast models dependent on beginning identification could work on the anticipated validness. A study was conducted by Sun *et al*., (2015) [40] to foster a speedy machine vision framework. This vision system was based on Time of Flight (TOF) three-dimensional imaging innovation for acknowledgment and area of citrus automatically. In order to identify the items and to gather the spatial data of organic products, they developed an image analysis algorithm by designing an versatile filter coupled between incomplete differential conditions filter and shock filter to eliminate commotion and hone edges. They specifically developed supported algorithms and programmed it for image acquisition and processing. From this system they acquired three-dimensional situation of the products of the soil by acknowledgment stages. The complete characterization results showed that near to 81.8% were distinguished and just a single time system made false detection.

Table 2: Peculiarity of advance and modern techniques for orchard management in fruit production

Sl. No.	Technique	Crop	Peculiarity	References
1.	Remote sensing	Peach	Spider mite damage is monitored using remote sensing. It helps to reduce cost of pest monitoring. Help to manage other pests also.	Luedeling *et al*., 2009 [28]
2.	Smart sprayer- Target-sensing sprayers	Apples	Reduced application rates of pesticide/insecticides by 15 - 40 percent and non-subject orchard soil deposition by 5 to 72 percent.	Giles *et al*., 2011 [14]
3.	Spring and summer pruning- allocation of Carbon to shoot that are fruiting.	Apricot and peach	Differentiation of flower buds is high in apricot. Maintenance of easier training system for peach. Better light distribution.	Neri and Massetani 2011 [33]
4.	Use of artificial neural networks	Apples	Effective identification of pests by analysis of model.	Boniecki *et al*., 2015 [1]
5.	Application of plant protection product system with measurement sensing.	All orchard crops	Precise application of chemicals and directing the air flow and the dosage rate properly to each tree canopy.	Berk *et al*., 2016 [2]
6.	Robotic-End effector - Automatic pruning of trees	Apple	Helps in branch pruning by cutting the branches up to 12 mm in diameter.	Zahid *et al*., 2019 [44]
7.	Intelligent machine for pruning by designed through algorithm related with 3D image processing	Grapevine	Acceptable performance and correct detection of pruning point of the grapevines with an accuracy of 96.8%.	Hosseini and Jaffari, 2017 [18].

Conclusion

Present review explains about various advance and modern fruit production techniques. Some of them are widely accepted due to their sustainability and low cost for production with high economic returns. Techniques which are related with robotics are quite expensive but advanced and affordable for profitable growers with large commercial production. Most techniques are even experimenting for the benefit of fruit industry. Soilless cultivation ensures higher productivity and better management of crops. Meadow orcharding is a technique which can be easily adapted by the fruit growers for higher yield with better quality fruits. Management of fruit crops is an important aspect as it holds the maximum share of time for production of improved quality fruits for the market. Thanks to modern techniques like use of drones, automatic robotic system, information technology for making different operations of fruit management in orchard like monitoring plants, automatic spraying of insecticides/pesticides, automatic pruning easier etc. From the review it can be concluded that the use of advance and modern techniques for fruit production helps the fruit growers by reducing time and effectiveness in different operations and by making this system more sustainable. These techniques are more beneficial because of its precise application and thereby maximize returns to growers. Hence the use of modern techniques will prove is a boon for fruit farming industry.

Future guidelines

- Research should focus on marginal fruit growers. Their problems should be evaluated and new techniques should be developed accordingly.
- Cost effective techniques can be developed and widespread, based on the principle of reuse, reduce and recycle.

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