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ESTABLISHING INTENSIVE PEAR ORCHARDS USING VEGETATIVELY PROPAGATED PEAR SAPLINGS IN THE ARAL SEA REGION OF THE REPUBLIC OF KARAKALPAKSTAN

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Abstract
This article examines the scientific and practical foundations for establishing intensive pear orchards using vegetatively propagated pear saplings under the soil and climatic conditions of the Aral Sea region of the Republic of Karakalpakstan. The effects of high temperatures, low precipitation, irrigation water scarcity, and soil salinity on the growth, development, and productivity of pear trees are analyzed. Recommendations are provided for selecting pear cultivars and rootstocks adapted to local conditions, determining planting schemes, implementing drip irrigation, and improving plant nutrition management. Particular attention is given to improving soil reclamation conditions, ensuring the quality of planting material, and implementing appropriate agronomic practices in a timely manner. These measures are considered essential for increasing the sustainability and productivity of intensive pear orchards in the region.

Keywords: Aral Sea region, Republic of Karakalpakstan, pear, intensive orchard, vegetative propagation, rootstock, scion, drip irrigation, soil salinity, productivity, agricultural technology.

Introduction

Today, one of the major priorities in the fruit and vegetable production sector is the establishment of intensive orchards, the rational use of available land and water resources, and the production of high-quality fruit. The introduction of modern horticultural technologies plays an important role in meeting consumer demand for fresh fruit, supplying the domestic market with high-quality products, and increasing the profitability of fruit production. Pear (Pyrus communis L.) is an important fruit crop distinguished by its nutritional value, pleasant taste, and versatility. Pear fruits are consumed fresh and are also used to produce juice, jam, compote, and other processed products. The biological characteristics of pear trees, differences in fruit ripening periods among cultivars, and the storage potential of their fruits expand the opportunities for growing this crop under intensive orchard production systems. The productivity of intensive orchards largely depends on the quality of planting material, rootstock vigour, cultivar characteristics, planting density,

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irrigation regime, and plant nutrition management. The use of vegetatively propagated rootstocks provides important opportunities for achieving uniform orchard development, regulating tree vigour, and implementing planned agronomic practices efficiently.

Establishing intensive orchards in the Aral Sea region of the Republic of Karakalpakstan requires careful consideration of the area's specific environmental conditions. The region's arid climate, high summer temperatures, low precipitation, soil salinity in certain irrigated areas, and limited water resources create considerable challenges for fruit production. Cold winters and sharp temperature drops in some years may also affect the winter survival of pear trees.

Therefore, orchard establishment requires the selection not only of high-yielding cultivars but also of suitable cultivar–rootstock combinations adapted to local climatic conditions, soil characteristics, and available irrigation resources. Research conducted in the Aral Sea region indicates that the reclamation status of irrigated land, soil salinity, and water-use efficiency are important factors influencing horticultural development [1, 2]. Consequently, establishing intensive pear orchards requires an integrated approach that combines planting material production with soil preparation, irrigation management, and salinity control.

Aim and Objectives of the Research

The aim of this research is to substantiate effective agronomic practices for establishing intensive pear orchards using vegetatively propagated pear saplings, taking into account the soil and climatic conditions of the Aral Sea region of the Republic of Karakalpakstan, and to develop practical recommendations.

The main research objectives are as follows:

- To assess the soil and climatic conditions of the Aral Sea region in terms of their suitability for establishing intensive pear orchards.
- To examine the biological characteristics and economic importance of vegetatively propagated rootstocks.
- To determine the criteria for selecting cultivars and rootstocks for intensive orchards.
- To develop recommendations concerning planting schemes, irrigation regimes, and plant nutrition systems.
- To identify approaches for reducing the adverse effects of soil salinity and improving the efficiency of water-resource use.

Soil and Climatic Conditions of the Aral Sea Region and Their Effects on Pear Production

In the Aral Sea region of the Republic of Karakalpakstan, the arid climate, high summer temperatures, low precipitation, and soil salinity in certain areas have a substantial influence on agricultural production. In the northern agroclimatic zone of Uzbekistan, including Karakalpakstan and Khorezm, challenges associated with a relatively short growing season, high summer temperatures, and, in some locations, the availability of irrigation water and the mineralization of groundwater have been reported [1]. Pear trees develop well when sufficient soil moisture and essential nutrients are available. However, high temperatures and soil moisture deficits may increase water loss through leaves, reduce photosynthetic activity, restrict the growth of young shoots, and result in smaller fruits. Soil salinity makes it more difficult for roots to absorb water and nutrients. In saline soils, plant water uptake may be impaired, leading to physiological drought

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even when soil moisture is present. For this reason, site selection for intensive pear orchards should consider not only soil fertility but also salinity levels and soil physical and hydrological properties. Before establishing an orchard, soil samples should preferably be collected from depths of 0–30, 30–60, and 60–100 cm. Laboratory analyses should determine salinity, texture, organic matter content, and nutrient availability. Where necessary, groundwater depth and mineralization should also be assessed. In areas with unsatisfactory soil reclamation conditions, drainage systems should be improved, irrigation water quality should be examined, and leaching practices should be implemented according to soil characteristics. Leaching should be undertaken only after considering drainage capacity and the availability of water resources.

The Importance of Vegetatively Propagated Pear Saplings in Intensive Horticulture In intensive horticulture, planting material quality and the biological characteristics of rootstocks directly influence the subsequent development of trees. Pear trees can be established using grafted planting material produced through vegetative propagation. This method helps preserve the characteristics of the selected cultivar and facilitates the establishment of orchards with relatively uniform growth and management requirements.

Vegetatively propagated rootstocks differ in their effects on tree vigour. Some rootstocks promote compact tree growth, whereas others produce more vigorous trees. Rootstock selection should therefore consider not only tree size but also root system strength, adaptation to local soil and climatic conditions, winter hardiness, and compatibility with the scion. For example, quince (Cydonia oblonga Mill.) is used as a dwarfing rootstock for certain pear cultivars. However, not all pear cultivars are equally compatible with quince rootstocks. In some combinations, weak graft unions or problems affecting long-term tree development may occur. In such cases, the use of an interstem or the selection of compatible vegetatively propagated pear rootstocks may be considered. In the Aral Sea region, one of the most important criteria for rootstock selection is its ability to perform under conditions of soil salinity and water scarcity. Nevertheless, it is not appropriate to classify every rootstock as salt-tolerant. Its performance depends on the composition and concentration of soil salts, irrigation water quality, and orchard management practices. Therefore, before establishing intensive orchards, promising rootstocks and cultivars should be evaluated under local conditions in small experimental plots. The assessment should include transplant establishment, annual shoot growth, leaf condition, winter survival, and resistance to major diseases.

Selection of Cultivars and Rootstocks for Intensive Pear Orchards When selecting pear cultivars, their biological characteristics and market demand should both be considered. Fruit taste, external appearance, size, storage potential, transportability, and ripening period are important factors determining the economic performance of an orchard. In the Aral Sea region, priority should be given to cultivars with adequate winter hardiness, the ability to maintain fruit quality under high summer temperatures, adaptation to local soil and irrigation conditions, and resistance to major diseases. Flowering time is another important consideration. Some pear cultivars have limited self-fertility and require compatible pollinizer cultivars to achieve satisfactory yields. Therefore, orchard planning should specify the arrangement of pollinizer trees alongside the main cultivars. Planting density in intensive orchards should be determined according to tree vigour,

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rootstock type, soil fertility, irrigation capacity, and the selected training system. Vigorous rootstocks may require a larger growing area per tree, whereas relatively dwarfing rootstocks allow trees to be planted more closely.

Recommendations for Selecting Planting Material and Sites for Intensive Pear Orchards
Table -1

Parameter	Recommended requirement	Practical significance
Type of planting material	High-quality grafted saplings that retain the characteristics of the selected cultivar	Promotes uniform orchard development
Root system	Well-developed, undried, and undamaged roots	Improves transplant establishment
Rootstock	A vegetatively propagated rootstock tested for suitability under local conditions	Allows tree vigour to be regulated
Scion	A promising pear cultivar adapted to the regional climate	Improves fruit quality and production stability
Soil salinity	Assessed through laboratory analysis	Helps identify salinity risks before orchard establishment

Planting Technology and Orchard Training The initial stage of establishing an intensive pear orchard involves selecting an appropriate site and preparing the land for planting. The site should preferably be level, have access to irrigation water, and allow excess water to be removed effectively. Before planting, soil texture, salinity levels, and nutrient availability should be determined. Based on the results of soil analyses, an organic and mineral fertilization programme should be developed. Excessive fertilizer application, particularly in areas at risk of salinization, may increase the concentration of salts in the soil solution. Planting can be carried out in autumn or early spring. Under the conditions of Karakalpakstan, the planting period should be determined according to the dormancy status of the saplings, soil moisture, the risk of winter frost, and irrigation availability. Saplings planted in autumn should be protected against winter cold, whereas spring planting should preferably be completed before the onset of active vegetation.Planting-hole dimensions should correspond to the size of the root system and the soil characteristics. Roots should be positioned naturally in the planting hole without bending. The graft union must remain above the soil surface. After planting, the soil around the sapling should be firmed, followed by irrigation to provide sufficient moisture in the root zone. Tree training is an important agronomic practice in intensive orchards. The training system should be selected according to rootstock vigour and planting density. Adequate light distribution, canopy ventilation, and favourable conditions for fruit development should be maintained. The need for support posts and trellis wires depends on the root system of the rootstock, the selected tree-training system, and exposure to wind. Since strong winds may occur in the Aral Sea region, orchard design should take prevailing wind directions and the establishment of protective shelterbelts into account.

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Seasonal Agronomic Practices in Intensive Pear Orchards Table -2

Period or developmental stage	Main agronomic practices	Expected outcome
Before planting	Soil analysis, land levelling, assessment of salinity and drainage conditions	Creation of suitable conditions for orchard establishment
Early spring	Assessment of winter damage, sanitary pruning, inspection of the irrigation system	Promotion of uniform tree development
Bud break and flowering	Monitoring soil moisture and organizing plant nutrition according to soil analysis	Support for vegetative and reproductive development
Fruit set	Regulation of irrigation and monitoring of pests and diseases	Improvement of fruit set and development
Fruit growth	Monitoring soil moisture, applying fertigation when necessary, and supporting branches	Improvement of fruit quality and stable tree development
Harvest	Determination of cultivar-specific maturity and careful fruit picking	Preservation of market quality and storage potential
After harvest	Assessment of tree condition, necessary irrigation and fertilization, and preparation of the orchard for winter	Improved readiness of trees for winter
Autumn and winter	Inspection of soil and drainage conditions and protection of young trees against cold	Reduction of the risk of winter damage

Management of Soil Salinity and Water Scarcity in Intensive Orchards Monitoring soil reclamation conditions is essential for ensuring the long-term productivity of intensive orchards in the Aral Sea region.

In irrigated areas, evaporation may lead to the accumulation of salts in the upper soil layers. This can restrict root activity and adversely affect tree growth. Effective salinity management requires determining the severity and chemical composition of the salts present in the soil. Different types of salinity cannot always be managed using the same methods. For example, in areas where sodium has degraded soil structure, applying additional irrigation water alone may not be sufficient. Such conditions require reclamation practices appropriate to the soil's physicochemical properties and an effective drainage system. When drip irrigation is used, particular attention should be paid to the uniform distribution of water within the root zone. The placement of emitters may be adjusted according to tree age and root system development. Young trees generally require a smaller wetted area, whereas the irrigated area should be expanded as trees grow. It is advisable to monitor irrigation water electrical conductivity and concentrations of sodium and chloride ions. These parameters are important for evaluating irrigation water suitability. Applying organic mulch to the soil surface may reduce evaporation and moderate fluctuations in soil temperature. However, the type and thickness of the mulch and its distance from the tree trunk should be selected appropriately. Organic material that remains excessively wet and in direct contact with the trunk may create favourable conditions for disease development.

Economic Efficiency of Intensive Pear Orchards In intensive horticulture, economic efficiency is determined not only by yield but also by product quality, production costs, water consumption, planting establishment rates, and opportunities for marketing the harvested fruit. Using high-

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quality vegetatively propagated planting material helps establish a uniform orchard, organize maintenance operations, and plan harvesting activities. However, the initial costs of establishing an intensive orchard—including the purchase of saplings, installation of a drip irrigation system, support structures, land preparation, and labour—may be higher than those associated with conventional orchards. Therefore, economic calculations should be performed before orchard establishment. These calculations should include sapling prices, the number of saplings required per hectare, irrigation system costs, fertilizers, plant protection products, labour expenses, and expected fruit sale prices.

The time required for intensive pear orchards to begin producing fruit depends on the rootstock, cultivar, planting density, training system, and quality of orchard management. Consequently, all intensive pear orchards cannot be assumed to enter production at the same time or achieve the same level of profitability. One of the important ways to improve economic efficiency under the conditions of the Aral Sea region is to monitor water consumption. Irrigation performance can be assessed by determining the volume of water applied per hectare, the amount of water used to produce one kilogram of fruit, and the proportion of irrigation expenses in total production costs. Furthermore, selecting cultivars with different ripening periods can distribute harvesting activities across the season, improve the use of labour resources, and facilitate a more continuous supply of fruit to the market.

Conclusion

Establishing intensive pear orchards using vegetatively propagated pear saplings in the Aral Sea region of the Republic of Karakalpakstan represents a promising approach to increasing fruit production and introducing modern horticultural technologies. However, the sustainability of such orchards depends on taking regional soil and climatic conditions and the availability of water resources into account. The use of vegetatively propagated rootstocks makes it possible to regulate tree vigour and preserve cultivar characteristics. At the same time, the biological compatibility of rootstocks and scions, winter hardiness, adaptation to soil salinity, and performance under water-deficit conditions should be evaluated in advance. The main agronomic priorities for establishing intensive pear orchards include using high-quality planting material, determining appropriate planting density, implementing drip irrigation, maintaining balanced plant nutrition, and improving soil reclamation conditions. Under the conditions of the Aral Sea region, particular importance should be attached to monitoring irrigation water quality, regularly assessing soil salinity, and ensuring the availability of an effective drainage system. In the future, field experiments should be established in different districts of the Republic of Karakalpakstan to compare promising pear cultivars and vegetative rootstocks. These experiments should evaluate transplant establishment, tree growth parameters, winter survival, yield, fruit quality, and water-use efficiency. The findings would provide a scientific basis for developing intensive pear production technologies adapted to the region. Thus, the use of high-quality vegetatively propagated pear saplings, the selection of cultivars and rootstocks suited to local conditions, and the application of resource-efficient agricultural technologies are essential prerequisites for the development of intensive horticulture in the Aral Sea region.

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