

# Cultivation Techniques of Qiuyue Pear in Shenxian County

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**Abstract** According to the production experience, the author summarizes the cultivation techniques of Qiuyue pear from orchard construction, shaping and pruning, fruit management, underground management, coping with natural disasters, and pest control, in order to provide a reference for producers.

**Key words** Qiuyue pear; Cultivation technique; Shaping and pruning

## 1 Introduction

The fruit of Qiuyue pear is slightly flat, subcircular<sup>[1]</sup>, with a single fruit weight of 300–400 g. Qiuyue pear is mature in early September, and is favored by the majority of consumers due to excellent food quality. At present, the cultivation area of Qiuyue pear in Shenxian is 333.33 hm<sup>2</sup>. However, there are problems of low yield and poor quality, and there are many cork fruits, with a good fruit rate of about 50%. According to the production experience, the author summarizes the cultivation techniques of Qiuyue pear from orchard construction, shaping and pruning, fruit management, underground management, coping with natural disasters, and pest control, in order to provide a reference for producers.

## 2 Orchard construction

(i) Site selection. According to the provisions of the national agricultural environmental standards, industrial and mining pollution areas should be avoided, while sandy soil, loam soil, and light saline-alkali land are appropriate. (ii) Row spacing of plants: (1.0–1.5) m × (3.5–4.0) m for spindle-shaped frame<sup>[2]</sup>, (1.0–2.5) m × (4–5) m for V-shaped canopy frame, 6 m × (7–8) m for cupuliform, rib-shaped and open center shaped frame; they can be densely planted at a density of 3 m × (3.5–4.0) m, and finally thinned to 6 m × (7–8) m. (iii) Pollenizer allocation. Hongxiangsu pear is selected as the pollenizer, and the main planting variety and pollenizer are arranged at a ratio of (5–8) : 1<sup>[3]</sup>. (iv) Ditching and fertilization. Planting furrow is dug in dense planting orchard, with a width of 1 m and a depth of 0.8 m; planting pit is dug in sparse planting orchard, with a size of 1 m × 1 m × 0.8 m (length × width × depth). The bottom is filled with 0.3 m thick straw, and every 666.7 m<sup>2</sup> soil is mixed with 500 kg oil residue cake fertilizer, or 1 000 kg of farm manure composted with straw, rotten branches and leaves, or 500 kg of commercial organic fertilizer in line with national standards and 100 kg of superphosphate or soil conditioner when backfilled. The soil layer retains the same when backfilled, and the ridge is sealed by the cultivated layer mature soil on both sides at 0.3 m below the ground. The ridge height is more than 30 cm after settling.

(v) Planting time. The pear trees are planted before germination in early and middle March in spring or before soil freezing from late October to middle November in autumn. (vi) Seedling specification; height above 1 m, root neck thickness above 0.8 cm. (vii) Planting method. The base marks of seedlings in the nursery should be flush with the ridging surface. The land should be irrigated thoroughly after planting, and about 20 cm thick grass is covered to preserve the soil moisture when the moisture content is appropriate.

Due to less root capillary roots of pear seedlings, pear seedlings have long rejuvenation period in the year of transplantation and can not grow vigorously. Therefore, the seedlings are cut to retain 20–40 cm to ensure survival and rapid growth after planting. When new shoots grow to 20–30 cm, a strong, upright shoot with good growth can be chosen as the trunk, and bound with bamboo rod. Other shoots should be pinched off to control the growth, and thinned in winter pruning.

## 3 Shaping and pruning

**3.1 Slender spindle-shaped tree** Slender spindle-shaped trees are suitable for the dense orchard with a plant spacing of (1.0–1.5) m × (3.5–4.0) m<sup>[4]</sup>. The tree is 2.5 m high, with a trunk height of 50 cm, and the central trunk is upright with obvious advantage, which produces large, medium and small fruiting branches. The average spacing is 20 cm, and trees are alternated and evenly distributed (Fig. 1).

**3.1.1 Pruning in the first year of planting.** After defoliation and before germination, the upright trunk branches should be mildly cut, and strong cut buds are retained, while other branches must be removed. Before germination in spring, the buds above 50 cm from the ground to 30 cm below cut buds should be carved with a saw or knife for more than 2/3 weeks to promote germination. The buds within 30 cm below the cut are not carved. When the budding shoots are 30 cm long, the angle is opened with toothpicks to promote reproductive growth. 15% Pacllobutrazol 120 times dilution should be sprayed from June to July, to inhibit the growth of summer and autumn shoots.

**3.1.2 Pruning in the second year of planting.** The elongated shoots of central trunk are cut and pruned to remove competing branches. Only medium and short branches and medium long



Fig. 1 Slender spindle-shaped tree of Qiuyue pear

branches are retained on the central trunk, while medium long branches are mildly cut. Prosperous branches with a thickness of more than 1 cm are heavily cut, remaining 3–4 buds at base. Short, medium and long branches drawn from the central trunk can bear fruit. Before germination, the elongated branches of central trunk and long branches retained on the central trunk continue to carve buds or cut rings at an interval of 30–40 cm (Figs. 2–3). After germination, when new shoots grow to 30 cm, the upright flourishing shoots germinated at the cut of central trunk and the upright shoots on the back within 30 cm below the cut buds of each long branch are removed, and other back new shoots are removed or pulled according to the development of new shoots on both sides, so as to promote flower formation in the current year.



Fig. 2 Good growth of short and medium branches with carving in spring



Fig. 3 Weak growth of short and medium branches without carving in spring

**3.1.3 Pruning in the third year of planting and beyond.** The elongated branches of central trunk are replaced with medium branches every year to maintain the height of the tree. The elongated branches are mildly cut, and competing branches are cleared and thinned to maintain uniaxial extension. When the thickness of the branches is greater than or equal to  $1/3$  of the central trunk, they should be retracted or thinned, and a short wooden stake of 15 cm must be left if empty space appears after thinning. Branches are selected after branching, retaining large ones. Large branch groups are generally renewed once every 3–5 years.

**3.2 V-shaped frame tree** V-shaped frame is 2.0–2.5 m high, in which fruits are resistant to wind, but it has high cost of construction<sup>[5]</sup>. It is suitable for high density planting with a row spacing of (1.5–3.0) m × (4–5) m. The trunk is 0.5 m high and the tree is 2.0–2.5 m high without central trunk. Each tree has two main branches forming an angle of  $180^\circ$ , which bifurcate to both sides. The main branch is opened at an angle of  $45^\circ$ , and there is no lateral branch in the main branch, while large, medium and small fruit branches grow directly. The bearing branches extend to both sides of the main branch and form an angle of  $90^\circ$  with the main branch, with an average branch spacing of 20 cm. The proportion and spreading range of large, medium and small bearing branches can be flexibly determined according to the inter-plant density, and it is appropriate to cover the shelf.

**3.2.1 Pruning in the first year of planting.** The trunk is cut to retain 60 cm, and apical 3–4 buds are removed. When new shoots grow to 30 cm, two strong and prosperous new shoots on both sides of the row are selected as main shoots for cultivation. Bamboo poles are inserted outside new shoots, and the angle is adjusted to make the upper strong branches opening at  $30^\circ$ , while the lower weak branches are allowed to grow upright. Other shoots should be topped to control the growth, and then thinned in winter. When the two main branches have balanced growth, with an opening angle of  $45^\circ$  and a length of 1.5 m, they are fixed by frame.

**3.2.2 Pruning in the second year of planting.** The two main branches are mildly cut, making them extend straight, and other branches are removed. Before spring germination, bud-notching is conducted below 30 cm from the tip of the main branch, or ring-cut is performed at an interval of 40 cm to promote branching. When new shoot grows to 30 cm, back new shoots within 60 cm below the extension branch are thinned, so as not to affect the growth of extension branch. New back shoots less than 60 cm are erased or pulled depending on the occurrence and fullness of new shoots on both sides, making them grow to both sides for flowering and fruiting. Paclobutrazol 120 times dilution is sprayed from June to July, to inhibit the growth of summer and autumn shoots.

**3.2.3 Pruning in the third year of planting and beyond.** The pruning of the main extension branch is the same as that of the second year. Branches on both sides of the lower part of the main branch can bear fruit. If the thickness is greater than 1 cm, 2 buds are left in the base and the average branch spacing is 20 cm. The large, medium and small branches are tied to the frame surface at an angle of  $90^\circ$  with the main branches. When the thickness of branches is greater than or equal to  $1/3$  of the main

branch, the branches must be retracted or thinned alternately, and large branches are renewed once every 3–5 years.

### 3.3 Cupuliform, rib-shaped and open center shaped tree

The frame is 2 m high, in which fruits are resistant to wind, but it has high cost of construction. It is suitable for low density and lower density orchards with the row and plant spacing of (6–7) m × (7–8) m and (3.0–3.5) m × (3.5–4.0) m<sup>[6]</sup>. The tree is 2.0–2.5 m high with a trunk height of 50 cm, and there is no central trunk. There are 3–4 main branches on the main branch at an opening angle of 45°, and each main branch is equipped with 2 lateral branches. On the lateral branches there are large, medium and small bearing branches. The angle between bearing branches and lateral branch is 90°, and the tree is in cupuliform, rib-shaped and open center shape.

**3.3.1 Pruning in the first year of planting.** The trunk is cut to retain 60 cm, and apical 3 buds are removed. When new shoots grows to 30 cm, 3–4 new shoots are selected and cultured as the main branches, with equal azimuth. A bamboo pole is inserted according to the predetermined distribution direction of main branches, to bind new shoots and adjust the opening angle, thus balancing the growth of main branches. The upper branch with the strongest growth is opened at an angle of 30°, followed by 20° and 10°. The weakest lower branch does not open the angle, making it grow upright. When the growth of each branch is balanced, the opening angle is 45°. Other branches must be removed or pinched as soon as possible, avoiding prosperous growth, and are thinned out in winter pruning. Each main branch is fixed by frame 1.2–1.5 m above the trunk.

**3.3.2 Pruning in the second year of planting.** Each main branch is mildly cut, leaving buds at the cut and making it extend straight. Bud-notching is conducted before germination or ring girdling is performed with an interval of 40 cm to promote branching. When new shoots grow to 30 cm, the back upright new shoot within 60 cm from the apex is removed, so as not to affect the growth of the extended head tip, and the back new shoots are erased, or pulled, and used for flowering and fruiting, depending on the growth of branch tips on both sides.

**3.3.3 Pruning in the third year of planting and beyond.** The pruning of the main extension branch is the same as that of the second year, and competing branches are removed. The oblique long branches on both sides of the main branch are mildly cut, and long branches are spaced at an interval of 25 cm with left-right distribution. Before spring germination, the extended branches and the long branches on both sides are girdled at an interval of 40 cm to promote branching. The medium, short and long branches on both sides can flower and bear fruit. There is no fruit left within 30 cm of extended branch apex.

**3.3.4 Equipping and cultivation of lateral branches.** Lateral branches are selected in the oblique branches drawn on both sides of the main branch. The first lateral branch is 1.2–1.5 m from the trunk, and the second one is 30–40 cm on the opposite position. The lateral branches form an angle of 45°–60° with the main branch, showing distinct subordination. The lateral branches on adjacent main branches are spaced 1.5–2.0 m. The pruning and cultivation of side branches are the same as that of main branches,

and they are selected for culture while fruiting without extra effort. When lateral branches are selected for cultivation, the large branches in front and rear of the lateral branches are moderately retracted, and transformed smaller or dispersed.

**3.3.5 Culture of branch group.** There are large, medium and small bearing branches on the lateral branches, forming an angle of 90° with lateral branches. They are spaced about 20 cm on average, with alternative distribution. The fruiting branch group can be lightly cut and slowly released when cultivating long branches, and then retracted after fruiting; the fruiting branch group can be retracted and then released when cultivating medium or weak long branches, and the front buds are cut off, leaving only leaf buds. When the front branches sprouted are fruiting, they are mildly cut to promote new branches.

**3.4 Transformation of closing orchard** When the canopy coverage rate of dense orchard reaches 100%, regardless of whether the tree shape is completed or not, thinning shall be carried out. Before thinning, lateral branches on the main branches of temporary plants are thinned year by year, and only the bearing branches are retained to make room for the development and extension of permanent plants. When the crown coverage rate of permanent tree reaches 100%, the main branches are all topped and the main branches are replaced by side branches. Tertiary tree structure is changed to secondary structure, so that the crown coverage rate of dense orchard remains 80%.

Qiuyue pear has vigorously growing long branches, more axillary flower buds and good fruit setting, and the fruits are large, but with late maturity and low sugar content. Therefore, it is necessary to promote the good development of medium and short fruit branches, and take into account all kinds of fruit branches in order to produce a high yield. When pruning, young trees should be more thinning and extremely heavily cutting, while upright shoots on the back should be pulled or thinned in time to balance branch potential, and the proportion of long branches should not exceed 10%. Mature trees should be retracted for many times, which should be conducted when the lateral branch thickness does not exceed 1/3 of the main branch, the branch group thickness does not exceed 1/3 of the lateral branch, and the thickness is greater than or equal to 1/3 of the mother branch<sup>[7]</sup>.

Before germination, the retained annual strong flourishing branches, the bare parts of triennial branches and the biennial branches with weak development of short and medium branches are performed bud-notching and girdling (girdling interval 40 cm), which can effectively inhibit the growth of strong and prosperous shoots and promote the development of short and medium spurs. When short and medium shoots on the back (about 30 cm long) are capped, 15% paclobutrazol 120 times dilution can be sprayed to inhibit the growth of long shoots and promote the differentiation of flower buds. The effect is unsatisfactory if the agent is sprayed too late.

## 4 Fruit management

**4.1 Supplementary pollination** Bees are released at flowering time, or the inflorescence is swept with a feather duster, or artificially pollinated. Supplementary pollination receives good fertiliza-

tion, and young fruits leave from flower calyx earlier, with early development and round shape.

**4.2 Flower and fruit thinning** Flower thinning is more conducive to saving tree nutrients and promoting fruit development. In view of frequent disasters in recent years, fruit thinning is dominated in production and is carried out 20 d after flowering. Deformed fruits, toptip fruits and dorsal fruits are thinned out, leaving one fruit every 25 cm<sup>2</sup> space<sup>[8]</sup>.

**4.3 Fruit bagging** Double paper bag is selected as the fruit bag. The outer paper blackens the inside to block the light, and the inner paper is yellow waxed paper. The outer bag made of native wood pulp paper is breathable and rain-resistant, and fruits will be bright and clean. Bagging starts in middle and late May from 8:30 on a sunny day when the dew disappears and the temperature rises to 17:30 when the dew falls. Insecticides and fungicides are sprayed throughout the orchard before bagging to ensure that the fruits are free from pests and diseases. The orchard soil must be moist before and after bagging.

**4.4 Foliage top-dressing** Before fruit bagging, 0.3% boric acid + 0.3% zinc sulfate should be sprayed for 3–4 times, and 0.3% urea should be sprayed once. In July, 0.3% urea must be sprayed once. In February before germination and September and October after harvesting, agents must be sprayed combined with orchard cleaning, while 0.3% urea is added to promote branch growth and flower bud differentiation. According to the occurrence of cork disease in fruits and the performance of branches and leaves in previous years, 0.3% calcium chloride or sugar alcohol calcium can be sprayed, combined with pest control throughout the year.

## 5 Underground management

Shenxian is dominated by salinized and alkaline tidal soil, with high soil salt content (pH 7.3–8.5) and insufficient organic matter content (less than 1%), while fruits are often deficient in nutrients. Underground management aims to increase the content of soil organic matter, improve soil physical and chemical properties, reduce soil pH value, and improve the supply of various nutrients by increasing the application of organic fertilizer, which can reduce the occurrence of physiological diseases such as fruit cork disease.

### 5.1 Fertilization

**5.1.1 Fertilizer.** Organic fertilizer, various kinds of oil residue cake fertilizer, crop straw, vegetable greenhouse residue seedlings, farm fertilizers retted by rotting branches and leaves from urban greening, commercial organic fertilizer in line with national standards can be applied to increase the content of soil organic matter. Calcium, boron, zinc, magnesium and other medium and trace element fertilizer necessary for the development of fruit trees must be applied. Nitrogen, phosphorus and potassium fertilizer can not be applied in large quantities, but a small amount of top-dressing and root top-dressing of nitrogen, phosphorus and potassium fertilizer can be done to avoid the supply imbalance of other nutrients that will lead to nutrient deficiency symptom. The salt content of manure in modern farms exceeds the standard and can not be applied directly, and the amount used in preparing farm fertilizer can not exceed 10%. Commercial organic fertilizers are

acidic bio-organic fertilizers containing humic acid and fulvic acid. It is forbidden to apply alkaline materials<sup>[9]</sup>.

**5.1.2 Fertilization time.** Fertilizers are mainly applied in autumn, and the amount sprayed in autumn accounts for more than 90% of the annual fertilizer. In addition to autumn fertilization, exoroot topdressing should be carried out at any time according to the indexes of tree structure.

**5.1.3 Fertilizer amount and fertilization method.** The amount of fertilizer applied is determined according to the indexes of tree structure, soil nutrient status, yield and fertilizer type. For example, Langzhong No. 2 bio-organic fertilizer (produced by Nongda Fertilizer Technology Co., Ltd.) has a total content of 10% nitrogen, phosphorus and potassium, 60% organic matter and 600 million beneficial bacteria per gram. When applying base fertilizer in autumn, 500 kg of Langzhong No. 2 is applied per 666.7 m<sup>2</sup>, while 40–60 kg of calcium superphosphate or 60 kg of high calcium magnesium potassium soil conditioner, 3 kg of zinc sulfate and 2.5 kg of borax can be added, to maintain an output of 2 500–3 000 kg. As fertilizers are broadcasted in the whole orchard, irrigation is carried out, and the fertilizers are plowed into the soil by rotary tillage.

**5.2 Water management** Before budding in spring and after defoliation in autumn, flood irrigation is carried out. During the growth period from germination to defoliation, small water irrigation should be carried out frequently. It is best to adopt drip irrigation, sprinkler irrigation, micro-spray and other water-saving irrigation methods. Alternate irrigation can be carried out in the area without such irrigation condition. The soil must be kept fully moist from germination to fruit expansion<sup>[10]</sup>. River water is the preferred choice of irrigation water, followed by well water. Mineral source fulvic acid can be flushed with irrigation at a dose of 2 kg/666.7 m<sup>2</sup>, 5 times a year. Drainage must be concerned in the rainy season to avoid long-term accumulation of water in the orchard.

**5.3 Grass planting technology** Grass can be planted between rows, such as *Medicago sativa*, *Galium odoratum*, *Lolium perenne* and *Vulpia myuros*, or they can be grow naturally. Grass mowing should not be too often, which should be done in drought and terminated in waterlogging, and grass may not be mowed if they do no affect operation walking. A height of 20 cm is maintained when mowing, and the mowing grass are piled under the tree. It can also be rolled down with an orchard working truck, and tilled into the soil when applying base fertilizer.

## 6 Response to natural disasters

Frequent natural disasters include high temperature in flowering period, late spring coldness from flowering period to young fruit period, and strong sunburn in fruit development period. The measures to deal with these natural disasters include planting grass in orchards and maintaining soil moisture, which have a preventive effect. When the disaster comes, it is better to promptly conduct sprinkler irrigation, micro-spraying, and elevated drip irrigation (above 1.5 m).

## 7 Pest control

**7.1 Physical and biological control** Physical and biological

measures such as raising ducks under trees, setting up solar insecticidal lamps, hanging sticky traps, insect sex attractant, sweet and sour liquid can achieve twice the effect with half the effort.

**7.2 Chemical control** Drug control should comply with the national drug regulations. Mineral-based, plant-derived and biological agents are advocated, combined with the use of chemical pesticides permitted by the state (limit the use frequency, concentrations and safety intervals), while prohibited drugs should not be administered<sup>[11]</sup>.

The main diseases of Qiuyue pear are mould core of fruits, scab and rust of leaves and dry rot of branches. 5° Be lime sulphur can be sprayed before germination to prevent dry rot. Polyox-ins 600 times dilution should be sprayed once at the time of near flowering and 80% of flower abscission, to prevent mould core of fruits. Before and after bagging, thiophanate methyl or benzyl benzoate 1 000 times dilution can be sprayed to control scab and rust, which will receive good control effect.

The main pests include *Aphanostigma jakusuiense*, *Psylla chinensis*, all kinds of fruit moths, red spiders, *etc.* Imidacloprid, acetamiprid, thiamethoxam, lambda-cyhalothrin + thiamethoxam, abamectin, spirotetramat and matrine all have good control effect on *A. jakusuiense* and *P. chinensis*. Agents are usually sprayed to control *A. jakusuiense* before and after fruit bagging. Thiamethoxam, chlorfluzuron, abamectin and matrine can be applied to control all kinds of fruit moths. Agents must be sprayed from the beginning of germination as early as possible to control *P. chinensis*. Spirodiclofen and azacyclotin should be sprayed separately before and after bagging to prevent red spider. After harvesting, lime sulphur and petroleum emulsion are mixed to clear the orchard.

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