Practical Manual of Efficient Cultivation Techniques for Tomatoes in Arches

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Preface

Tomato (scientific name: Lycopersicon esculentum Mill.), an annual or perennial herb of the genus Lycopersicon, is one of the most commonly cultivated fruit and vegetables in the world. Its fruits are nutritious, have a special flavor, and are widely consumed raw, as a vegetable, or processed into tomato paste, tomato juice, or canned whole fruits. The tomato originated in Peru and Ecuador in South America, and there are still original wild species in the Andes.

The Mekong River Basin countries are mainly Myanmar, Thailand, Laos, Cambodia and Vietnam, bordered by Tibet and Yunnan Province of China in the north and the Indian Ocean in the south. Most of them have a tropical and subtropical monsoon climate, which is especially suitable for the growth of fruits and vegetables. In recent years, the vegetable industry in the Mekong River Basin countries has developed to a certain extent, but the development of the vegetable industry is extremely uneven. According to the United Nations Good Seed Organization 2018-2020 statistics of 25 categories of vegetable categories, the Mekong River Basin countries, in addition to China, the largest number of vegetable cultivation categories is Thailand, and only Thailand cultivated tomatoes have data statistics, other countries planted tomatoes less, the yield is also relatively low. Tomato production in these countries is basically open field natural state, the lack of protective cultivation facilities and equipment, especially the lack of rain, shade facilities and equipment, management is sloppy, can not achieve annual production, tomato industry has greater potential and space for development.

The promotion of trellis tomato annual high-efficiency cultivation technology in the Mekong River Basin promotes both safe, high-quality and efficient tomato production and development, and contributes to local income and economic development.

The efficient cultivation of tomatoes in greenhouses is a systematic project, and this book covers many aspects of tomato seedling greenhouse facilities, planting, field management, and soilless cultivation techniques. This book provides guidance on the development of the tomato industry in the Mekong River Basin by addressing many aspects such as “tomato seedling”, “greenhouse facilities”, “planting”, “field management”, and “soilless cultivation technology in greenhouses".

Contents

Part I. Tomato seedling technology

Tomato seedling cultivation is the process of cultivating tomatoes in seedbeds from sowing or cutting to planting in the field and is an important technical aspect of tomato cultivation. The success or failure of seedlings or the quality of seedlings directly affects the yield and economic benefits of tomatoes. During the tomato seedling stage, the flower buds that form the early yield have already finished differentiating, therefore, the growth condition and physiological quality of tomato seedlings affect the differentiation of flower buds, fruit setting and fruit development. Nowadays, the most common are tomato factory seedlings, grafted seedlings, cuttings, etc., which can provide age-appropriate and strong seedlings for tomato production and reduce the cost of seedlings, laying the foundation for abundant tomato production.

I. Basic technology of factory nursery

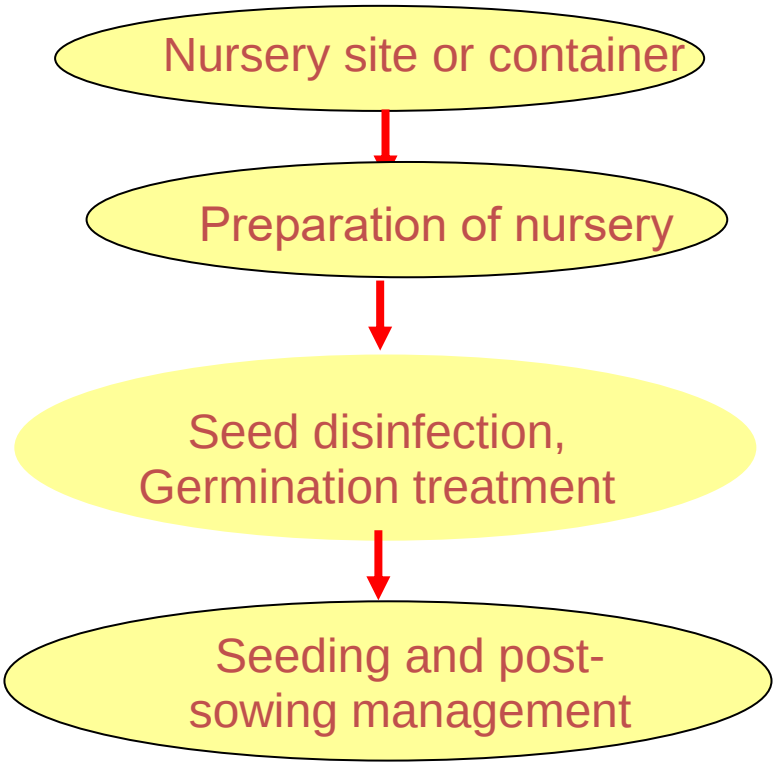

Figure 1-1 Schematic diagram of tomato factory nursery operation steps

(i) Pre-nursery preparation

1. substrate preparation: tomato seedling substrate mainly consists of grass charcoal, vermiculite, perlite and other mixes, the summer ratio of grass charcoal: vermiculite: perlite = 7:2:1, the winter ratio of grass charcoal: vermiculite: perlite = 6:1:3, mixed evenly in proportion to the spray water until its water content reaches 60% can be.

2. cavity tray selection: use 90-hole or 105-hole cavity trays in summer and 72-hole or 50-hole trays in winter.

Figure 1-2 Tomato factory nursery substrate and cavity tray preparation

3. Fertilizer: Use water-soluble fertilizer for seedlings, such as N:P:K ratio: 20-10-20, 14-0-14, potassium dihydrogen phosphate, etc.

4. Seed treatment: Seed treatment mainly includes seed screening, disinfection, germination, etc.

(1) Seed screening: Under the premise of choosing good varieties, you should choose high quality seeds of 1 to 2 years of purity above 95%, clarity above 99%, and high germination rate.

(2) Seed disinfection.

Warm scalding soaking: The tomato seeds were first soaked in cool water for about 10 minutes so that the velvet hairs on the surface of the seeds would absorb water and become wet, so that the seeds would not float on the surface when scalding and the heat would be easily conducted to the inside of the seeds. Then the seeds were placed in warm water at about 50°C for stirring and supplemented with hot water at any time to keep the water temperature stable at 50 to 52°C for 15 to 30 minutes. After the seeds were treated in the warm water, they were placed in cool water to dissipate the residual heat, and then the seeds were soaked for 4 to 5 hours before germination.

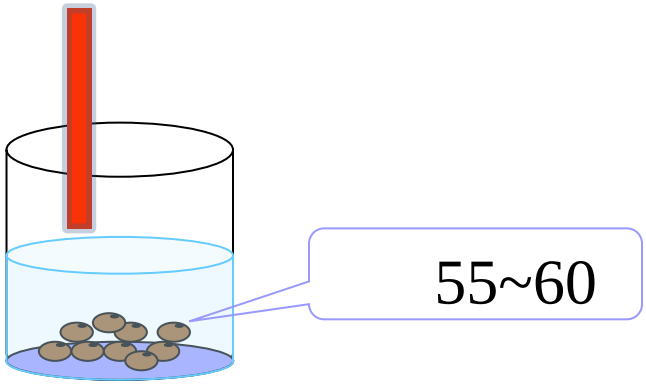

Figure 1-3 Warm soup for seed dipping

Pharmacological treatment: To prevent and control tomato tobacco mosaic virus disease,

tomato seeds can be soaked in water for 3-4 hours, then put into a 10% solution of trisodium phosphate for 20-30 minutes, or into a 2% aqueous solution of sodium hydroxide for about 20 minutes to remove and rinse with water until no residue of the solution remains. Prevention of early blight and other diseases, disinfection can be formalin, soak 4-5 hours of tomato seeds into a 1% formalin solution soaked in 15-20 minutes, then pulled out, wrapped in wet cloth, put into a closed container, smothered for 2-3 hours, so that the full effect of the agent to remove the seeds with water repeatedly rinsed clean. Prevention of ulcer disease and mosaic virus can be disinfected with potassium permanganate, soak the seeds in warm water at 40 ℃ for 3 to 4 hours, put them in 1% potassium permanganate solution for 10 to 15 minutes, and then remove the seeds and rinse them with water.

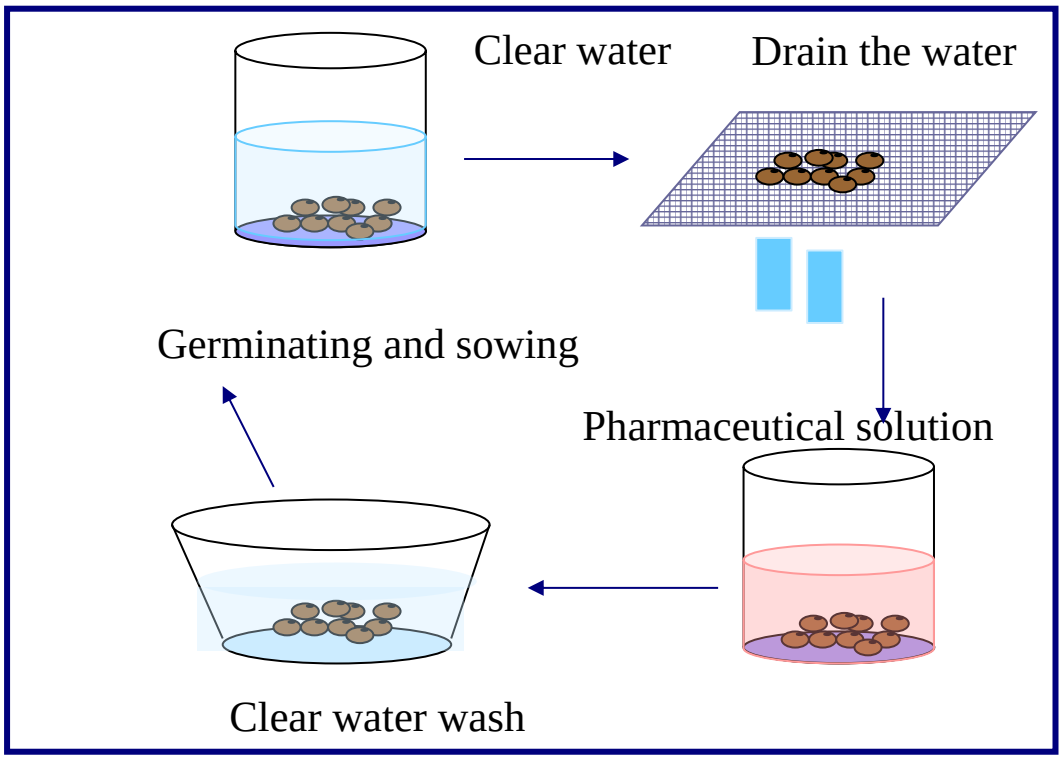

Figure 1-4 Pharmacological treatment

(3) Seed soaking and germination

Immerse and germinate tomato seeds immediately after treatment. After 2 to 3 days of germination at a temperature of 25 to 28°C, 60% of the seeds should be sown immediately when they "break the mouth and show the white" and reveal the radicle. This step is not necessary for mechanized sowing.

(ii) Sowing : The process of filling the substrate and sowing seeds for factory seedlings is shown in Figure 1.

Figure 1-5 Schematic diagram of factory seedling sowing

1. fill the substrate: the prepared substrate into the cavity tray, slightly suppressed, but also not too hard, so that the substrate filled the cavity holes and elastic.

2. Perforation: Use a hole punch to make a hole in the center of the hole, 0.8 to 1.0 cm deep.

3. Sowing: Place the seeds in the center of the hole, 1 seed per hole, with the seeds placed flat.

4. Covering and watering: cover with perlite or vermiculite, to cover the surface of the surface of the cavity tray with a flat surface is appropriate, the first watering to water thoroughly.

5. Into the germination room: according to the tomato seed germination requirements for temperature and humidity, the general temperature is controlled at 25-30℃ and humidity is above 90%.

6. Emergence from the germination chamber: Generally tomatoes can emerge from the germination chamber in 3 d. The radicle is 5 to 8 mm long and the embryonic axis is bent to the top of the soil.

Figure 1-6 Arrangement of seeds after sowing for emergence

(iii) Post emergence management.

1. Temperature and humidity management: 28℃ during the day and 20℃ at night, with 80% humidity. When the substrate surface is dry, spray water appropriately to increase the humidity for neat emergence. When the sun is strong at noon, you can pull the shade net shade. As the seedlings grow, the temperature gradually decreases from 28℃ to 24℃ during the day and from 20℃ to 15℃ at night. Humidity should also be gradually reduced. Reducing humidity can effectively reduce the occurrence of diseases. Give seedlings sufficient light when the temperature is suitable. Only when the temperature is too high is it properly shaded for a short time at noon to lower the temperature.

2. Fertilizer application: Start watering on the 2nd day after transplanting, on a sunny

morning. Water-soluble compound fertilizer can be applied 2 to 3 times.

3. Plant height control: In the middle and late stages of seedling growth, the temperature can be lowered by controlling water to control the height of seedlings and increase the thickness of stalks, or foliar spraying of potassium dihydrogen phosphate 500 to 1000 times 2 to 3 times. If the plant grows too vigorously, chemical control is needed when the height cannot be controlled by natural regulation. Chemical control is usually done before 10:00 on the second day of fertilization. Spray 10~15 mg/L polyconazole depending on the situation.

4. Pest and disease control: The principle of pest and disease control in factory seedlings is based on prevention, and the temperature is required to be below 30℃ at the time of drugging. Generally, one to two fungicides and one insecticide are used together. For example, for the prevention and control of sudden collapse disease, use 800 to 1,000 times of Priligy, 800 times of Dakonin (Chlorothalonil) or 800 times of oxamycin for root irrigation; for the prevention and control of tomato leaf spot disease, use 500 times of Chlorothalonil, 500 to 800 times of Dasen M-45 (Dyson Manganese Zinc), 800 times of methyltobutoxin; for the prevention and control of early blight, use 1,000 times of Suppression of Fast Net + 800 times of Tetramycin; for the prevention and control of For late blight, use 1,000 times of amoxicillin; for gray mold, use 1,000 times of quicklime. For aphids and whiteflies, use 3,000 times of Acetate, 1,000 times of acetamiprid, 1,000 times of imidacloprid and 1,000 times of omethoate; for spotted fly, use 1,000 times of Avermectin, 1,000 to 1,500 times of high efficiency cypermethrin and 1,000 times of green vegetable treasure (Avermectin-Dichlorvos); for cabbage moth and beet moth, use 1.8% of Avermectin emulsion and 1,000 times of Avermectin emulsion. Avermectin emulsion 2,000 times, high efficiency cypermethrin 1,000 ~ 1,500 times, vegetable 1,000 times, methomyl 1,000 times or chlorfenvinphos 800 times.

(iv) Pre-planting seedling refinement

Generally with 4 to 5 true leaves can be planted, before planting generally do not need to water fertilizer. The main management of this period is to adapt to the planting environment, lower the temperature and increase ventilation, so as to adapt to the planting environment as soon as possible. In order to reduce pests and diseases, you can do a fungicide and insecticide in the afternoon to prepare for the planting on the second day.

Figure 1-7 Tomato factory seedling emergence and post-emergence management

(E) strong seedling standards

The seedlings are about 28 to 45 days old, about 20 cm high, with a stem thickness of 0.5 cm or more and the same thickness above and below, short internodes, equal spacing between nodes, robust, with cotyledons and 7 to 9 true leaves, balanced above-ground and below-ground development, well-developed root system, white roots and many beards, fat leaves, sound leaves, dark green leaves, purple leaves on the back and basal stem, fat and full flower buds, with a high number of flowers, and the first The first inflorescence is borne on the seventh to ninth node, without pathogenic bacteria and insects.

Ⅱ. grafting seedlings

Grafting seedlings to control brucellosis, brown root rot, blight, root-knot nematode disease, etc. The method of grafting seedlings can be plugging, leaning, etc. Grafting seedlings are generally more viable and easier to operate.

Grafting nursery technology points.

1. Rootstock selection: Select rootstocks with strong affinity and disease resistance and target them as needed. Such as Toru Bam, Dutch selected KVFN rootstock, etc.

2. pre-planting preparation: tomato grafting seedlings are generally used in cavity trays, in order to prevent grafting operations in the rootstock and scion inverted connection, rootstock and scion seedling tray should be used separately with different sizes of cavity trays,

or different colors of the seedling tray to distinguish, re-use of the seedling tray can be 800 times the potassium permanganate soaked disinfection. Seedling substrate can be deployed by themselves, but also directly purchase commercial seedling substrate. Prevent the substrate from carrying bacteria when preparing the substrate by yourself.

3. sowing: tomato grafting seedlings require grafting of each tray of rootstock seedlings and scion seedlings neat and consistent, convenient operation, can also be used in sections of seedlings, that is, first sowed in a square tray, seedlings and then moved into the cavity tray according to the size of cultivation.

4. seedling seedbed management: the management of seedlings before grafting is mainly to prevent tomato seedlings from growing, specifically through ventilation and other methods to regulate the temperature and humidity, but also through chemical control to make tomato seedlings strong.

5. Grafting.

(1) preparation before grafting: two days before grafting to the tomato seedlings spray a fungicide, grafting the day before the tomato seedlings to water enough water.

(2) grafting method: grafting method, the rootstock transplanted at the beginning of the true leaves, planted 3cm apart from the scion, 3 true leaves, in the node with the first or second true leaves for grafting. Plugging method of grafting, rootstock to be sown about 7 days earlier than the scion, when the rootstock true leaves 4 to 4.5, the scion 2.5 leaves. The rootstock retains 3 true leaves for heart picking. Stem short in the second true leaves above the leaning connection, other management reference to conventional nursery technology.

6. Grafted seedling seedbed management

The optimum growth temperature of grafted seedlings is 25 ℃, the temperature is lower than 20 ℃ or higher than 30 ℃ are not conducive to interface healing, affecting the survival rate. After grafting seedling place to close moisture, grafted seedlings before grafting should be fully watered to ensure that the air humidity is 99% within 3 to 5 days after grafting. After grafting 2 to 3 days may not be ventilated, the third day after the choice of warm and high air humidity in the evening and early morning ventilation, ventilation 1 to 2 times a day, 6 to 7 days after normal management.

Figure 1-10 Tomato grafted seedlings and strong seedlings

Part II The arch tomato cultivation facilities

The main common forms of facilities used in arch tomato cultivation facilities are arches, joint arches and supporting facility materials.

I. Arches

A shed with a curved top covered with a screen or plastic film. The size of the arch depends on the crop to be cultivated, and there is no uniform specification. The span is 0.5m~36m; the height is 0.5m~5m, or even higher; the skeleton is either bamboo pole, bamboo pole + cement column, or steel frame; the purpose is to prolong the growing time of crops and get higher yield and benefit.

Figure 2-1 Single large arch which grows tomatoes

II. Joint arch house

Continuous arch is an upgraded existence of arch, in fact, it is a kind of super arch, which takes the original independent single-room arch and connects the original independent single-room model with scientific means, reasonable design and excellent materials.

The advantages of continuous arch are: it greatly improves the available land area, has the advantages of high intelligence, more uniformity, more scientific operation, saving time and improving efficiency. The disadvantage is the high cost of construction, ventilation, dehumidification, heating and cooling require power, and the cost of use is high. This kind of continuous arch is common in developed countries such as Europe, America and Israel. Although the construction cost is high, but the temperature, light, moisture and nutrients in this kind of facility basically realize automatic control, and there is no column, which is convenient for mechanized operation, suitable for the developed countries where there are fewer agricultural practitioners and labor shortage. In combination with soilless cultivation,

it is even more suitable for production in most areas not suitable for agricultural cultivation.

Figure 2-2 Appearance of the continuous greenhouse

Figure 2-3 Soilless tomato cultivation in a continuous greenhouse

III. Over-summer cultivation facilities

Summer is hot, rainy, and has many characteristics such as excessive light, high temperatures, and too much rain, all of which can adversely affect tomato growth and expose it to the dangers of disease, making tomato cultivation difficult. The adoption of advanced cultivation facilities improves the growth environment of tomatoes and reduces the damage caused by pests to the growth of vegetables. It also improves the economic returns of growers and creates a good growing environment. Over-summer cultivation facilities generally include shade nets, insect screens, etc.

(I), shade net

Shade net, also known as shade net, can play a role in blocking light, rain, moisture and cooling after covering in summer, and there is a certain role of heat preservation and humidification after covering in winter and spring. In the summer cultivation of horticultural crops has been more widely used. Shade net shading rate is generally 20% to 90%. Production of black and silver gray shade net. Black shade net shading and cooling effect is better, suitable for high temperature season and low light intensity requirements of vegetables cover. Silver gray shade net has good light transmission, avoiding aphids and preventing virus disease damage, suitable for early summer, early autumn season and higher requirements for light intensity of vegetable cover.

The application of shade netting mainly lies on the coverage of different cultivation facilities. The shade nets for greenhouses are applied to the plastic greenhouse skeleton or on the plastic greenhouse film, keeping the distance between the two sides of the net and the ground at 1.6 to 1.8m, which can facilitate the circulation of natural wind. Or hang the shade net in the greenhouse 1.2 ~ 1.4m from the ground, adapt to the production of greenhouse tomatoes for over-summer cultivation or autumn extended cultivation and autumn vegetable nursery. Cover shade net used in small and medium-sized greenhouses on the arch can keep the temperature inside the greenhouse moderate, to meet the needs of vegetable growth. In the summer and autumn season, choose the skeleton of small and medium-sized arches as a support to cover the shade net, due to the superior planting conditions, can be planted in the shed in advance of the autumn vegetables. Shade net can also be used for floating surface cover, generally can be called direct cover, floating cover, border cover, etc. Its main is to cover the shade net directly on the border or plant, and then a class of methods for vegetable planting. And floating cover can be done in open field, small and medium shed, large greenhouse, etc., usually for the convenience of vegetable emergence.

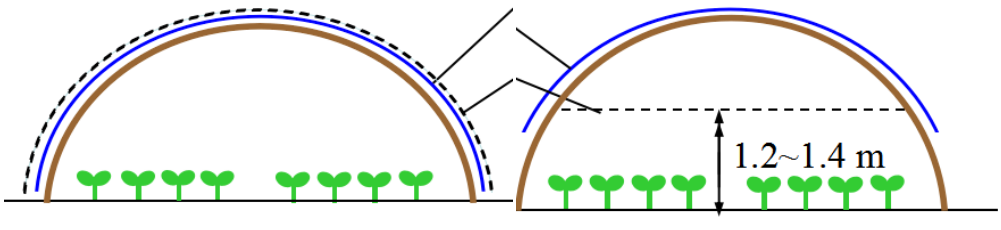

Figure 2-4 Schematic diagram of large arches covered with shade net

Fig. 2-5 Large arches covered with shade net

(ii) Insect-proof net

Insect net cultivation is to build artificial isolation barriers by covering the trellis with insect netting to keep pests out of the net, cut off the way of pest (adult) reproduction and migration, and effectively control the spread of various pests, such as cabbage borer, vegetable borer, small cabbage moth, aphid, flea beetle, beet night moth, American spotted fly, and oblique night moth, as well as prevent the harm of virus disease transmission. And with light transmission, moderate shading, etc., can create favorable conditions for crop growth, to ensure a substantial reduction in the application of chemical pesticides in vegetable fields, so that the output of high-quality crops, health, for the development of the production of pollution-free green agricultural products to provide a strong technical guarantee. Pest control nets also have the role of resisting natural disasters such as storm washing and hailstorm attack.

Most of the options of insect netting cover methods are to use insect netting to add insect netting to all the vents, back windows and entrances of the shed, and then to close all the front and back vents. The main forms of covering are as follows.

（1）Cover the insect protection net directly on the trellis frame, surrounded by soil or bricks to press tightly and compact, and fasten the net with pressure film line, leaving the front door uncovered.

（2）Bamboo or steel bent into a small arch, inserted in the field bed, the insect protection net over the arch, later watering directly on the net, until the harvest are not uncovered, the implementation of full closed coverage.

（3）Use horizontal trellis cover.

Fig. 2-6 Large arches covered with insect-proof nets

Insect protection net shade less, no need to cover day and night or before and after the cover, must be covered for the whole growth period, do not give the pests have the opportunity to invade, in order to receive satisfactory insect control effect.

At present, there are various kinds of insect-proof nets on the market, such as 24-mesh, 30-mesh, 40-mesh and 50-mesh, but the insect-proof effect and light transmission rate will be affected by the chosen specifications. The smaller the number of mesh, the weaker the insect control effect, on the contrary, the better the insect control effect. From the real planting situation, we mainly choose 30 mesh insect screen with good insect control effect and good ventilation.

Part III Tomato Planting

I. Soil requirements for tomatoes

Tomatoes do not have strict soil requirements. Deep, well-drained clay loam and sandy loam soils rich in organic matter, water and fertilizer retention, and good air permeability are acceptable. Soil pH 6 to 7 is appropriate, too acidic, too alkaline should be improved.

Ⅱ.the preparation before planting

1. Preparing the land and making borders

After the previous crop is harvested, the land can be prepared and dried. In combination with the land preparation, apply 5000Kg-6000Kg of well-rotted high quality farmyard manure, 50Kg of nitrogen, phosphorus and potassium compound fertilizer as base fertilizer and 100Kg of calcium superphosphate. 1.5 Kg of carbendazim powder and 0.8 Kg-1 Kg of phoxim are mixed into the land with serious soil-borne pests and diseases, and then turn it twice deeply to make the soil, fertilizer and pesticide mixed. Make a flat bed, or use a small raised bed, and prepare for planting.

Figure 3-1 Fertilizer application, tilling and land preparation

2. Planting

In winter and spring, choose a sunny day for planting in the morning, and choose a cloudy day or afternoon for planting in summer cultivation to avoid high temperature and sunshine to facilitate the slowing down of seedlings. Water in time after planting. Cultivation density varies according to the cultivation season and cultivars. Early varieties, you can choose row spacing 40 to 50cm, plant spacing of about 30cm, 4,000 to 5,000 plants per mu; medium-ripening varieties row spacing 50 to 60cm, plant spacing 30 to 35cm, planting 3,000 to 4,000 plants per mu. Late varieties of row spacing 60 ~ 80cm, plant spacing 35 ~ 40cm,

planting 2600 ~ 3200 per mu. Generally use the water-stable seedling method, first open a trench according to the row spacing watering, the seedlings will be spaced according to the plant, to be underwater seepage after sealing the trench with soil. Also available cavity planting method, digging holes according to the plant spacing, seedlings planted after watering, water seepage under the mulch. Planting depth to the surface of the seedling heap is 1cm below the border surface is good. After planting in the low temperature season, cover the ground with mulch.

Figure 3-2 Tomatoes after planting

Part IV field management techniques

I. Fertilization and watering techniques

1. Water requirements of tomatoes

The tomato plant has lush stems and leaves, strong transpiration, a well-developed root system, and strong water absorption capacity, making it a semi-drought tolerant crop that is drought tolerant and requires a lot of water. Tomatoes require air relative humidity of 45%-50%, too much air humidity, preventing normal pollination. High temperatures and humidity can easily cause a variety of diseases.

Tomatoes have different moisture requirements during different reproductive periods. The germination period requires more water, and after sowing requires a soil moisture level of 80% or more. Seedlings grow quickly, and to avoid growth and disease, the soil should not be too wet and watering should be properly controlled to maintain a relative soil humidity of 65% to 70%. Before the first inflorescence of fruit, too much soil moisture is prone to growth, poor root development, often resulting in flower drop. After the first inflorescence of fruit expansion and growth, water supply needs to be increased. The fruiting season needs frequent watering, but not to cause excessive soil moisture, if the drainage is poor, easy to rot the roots and die. Improper soil moisture control during the fruiting period can cause serious umbilical rot disease, and the soil can be dry and wet at times, which can easily cause massive fruit cracking. Soil moisture should be maintained at 60% to 80% during the fruiting period.

2. Fertilizer requirements of tomatoes

Tomato plants have a long reproductive period with continuous flowering and fruiting, and need to absorb a large amount of nutrients from the soil. Production must focus on reasonable fertilization, organic and chemical fertilizers with the application to meet the plant growth needs of various nutrients.

Nitrogen fertilization plays an important role in stem and leaf growth, fruit development and yield formation. Before the first inflorescence sits and expands, the plant's uptake of nitrogen gradually increases, and then it absorbs nitrogen at the same rate throughout the reproductive process, reaching a peak at the peak of fruiting. Therefore, nitrogen must be adequately supplied. Tomatoes do not absorb much phosphorus, but phosphorus has a significant effect on tomato root and fruit development. Increased application of phosphorus fertilizer during the seedling stage will promote bud differentiation and flower development. Tomatoes take up the most potassium, especially during fruit expansion, to promote fruit development and improve quality; potassium also helps to enhance plant resistance. In

addition, tomatoes require calcium, magnesium, iron, sulfur, boron, manganese, zinc, copper, molybdenum, etc. Lack of any of the macronutrients and trace elements can result in adverse symptoms and lead to a variety of more complex physiological diseases.

3. Tomato fertilizer and water management techniques

Characteristics of tomato fertilizer needs: the seedling growth is small and requires less fertilizer, which should be controlled to prevent growth and reduce diseases. After planting and before flowering: water the planting water, control the fertilizer appropriately, squat the seedlings, promote the root growth, and promote the rapid return of the plant to viability. Flowering and fruiting period: fertilizer needs are large, appropriate fertilizer to promote plant growth and development, flowering and fruiting, improve quality and increase yield.

Fertilization principles: fertilization is based on well-rotted organic fertilizer, and nitrogen, phosphorus and potassium are reasonably coordinated; fertilization should be carried out according to soil fertility, climate characteristics and plant growth; under the premise of strict control of excessive application of nitrogen fertilizer to reduce the nitrate content of fruit, the method of fertilization should be mastered as "small at both ends and large in the middle": that is, diligent application in the early stage, light application to promote seedling In the early stage, the fertilizer should be applied diligently and lightly to promote the growth of seedlings; in the blooming and fruiting period, the rotten animal and human fertilizer and fast-acting phosphorus and potassium fertilizer should be applied heavily to ensure the needs of blooming and fruiting; in the late stage, the light animal and human fertilizer should be applied moderately to prevent early decay and increase the late yield; in the harvesting period, the organic fertilizer should be used mainly to control the amount of nitrogen fertilizer and reduce the nitrate content of fruits.

Before flowering using watering, after flowering using irrigation, irrigation shallow furrow water, quick irrigation and drainage, do not flood moisture. According to the tomato field growth, weather conditions, soil dryness, to the morning to watch the tip of the leaves without dew droplets as a sign of irrigation, generally 7 to 10 days to irrigate once.

Ⅱ. temperature management

The principle of temperature requirements for tomatoes is "low temperature for seedlings, high temperature for fruits". Seed germination temperature of 25 to 30 ℃, seedlings during the daytime temperature of 20 to 25 ℃, 10 to 15 ℃ at night, the appropriate daytime temperature of 25 to 30 ℃ during the fruiting period, the night temperature of 13 to 17 ℃. The optimal temperature for fruit coloring is 24℃. Winter cultivation ground temperature is more important for tomato growth than air temperature, and the optimum soil temperature for root growth is 20 to 22℃. According to local cultivation conditions, a variety

of measures are taken to regulate the environmental temperature and meet the temperature requirements during different fertility periods of tomatoes in order to achieve the goals of disease free, high yield and high commercial fruit.

According to the characteristics of tomato growth and development, temperature management is carried out through heating system, cooling system and air release to maintain 25~30℃ during the day and 12~18℃ at night.

Specific operating procedures, high-temperature season to prevent high temperatures, all the shed air vents open all day, and at noon depending on the temperature situation pulled on the shade net cooling, forced ventilation when necessary to cool. In winter or when a cold wave comes, the second curtain should be added to keep warm, and if necessary, smoke and temporary heating measures should be taken.

Ⅲ. the management of light

Tomato is a light-loving crop, but light requirements are not very strict and can be cultivated year-round as long as the temperature is appropriate. The light saturation point for photosynthesis in tomato is 7000 lux and the light compensation point is 2000 lux. As light intensity decreases, the photosynthetic rate of the plant decreases. Therefore, good light conditions should be ensured in cultivation, which should generally reach 30,000 to 35,000 lux, to maintain normal growth and development.

Tomato is a short daylight crop, most varieties flower early under 11 to 13 hours and the plants grow robustly. A few varieties flowered earlier under short sunlight. Tests showed that dry matter yield of tomatoes increased significantly under 16 hours of light.

Tomatoes have different light requirements for different reproductive stages. Insufficient light delays the differentiation of flower buds, increases inflorescence nodes, reduces the number of flowers and poorly developed floral organs, which affects fruit growth; insufficient light during the flowering period results in poor pollination and fertilization, which can easily cause flower drop; when there is sufficient light during the fruiting period, there are more fruits and larger single fruits; when there is low light, the fruit set rate and single fruit weight decrease, and hollow fruits and sinewy fruits easily appear. In low light, the fruit set rate and fruit weight are reduced, and hollow fruit and ribbed fruit may appear.

In autumn and winter, the overall light can be improved by eliminating old, weak and diseased plants in low light conditions and by timely leaf removal through whole branches.

IV. Plant adjustment techniques

Tomato cultivation is one of the key techniques to obtain high yield and high efficiency by adjusting the plant to control stem and leaf nutrient growth and promote flower and fruit development. Timely and appropriate branching and adjustment is an effective way to tap the

inherent yield potential of the plant. Tomato plant adjustment is mainly carried out by forking, heart picking, removal of old yellow diseased leaves, flower and fruit thinning and other operational techniques.

1. fork: tomato lateral branch formation ability is strong, remove the leaf axils in the growth of excess and useless lateral branches, the so-called fork, fork can reduce nutrient consumption to ensure the normal growth of the main stem or fruiting branches and flowering and fruiting. Forking should not be done too early, it will reduce the growth potential of the plant and make it easy to senesce. When the lateral branches produce obstacles to the surrounding leaves, flowers and fruits, leave a leaf to be removed. Forking should not be done too late, as excessive indulgence in growth can easily lead to apprenticeship and group depression. Timely forking is good for enhancing photosynthesis of the middle and lower leaves of the plant, improving the structure of the group in the field, concentrating the fruit harvesting period, and improving the fruit quality and yield.

2. heart picking: heart picking is topping, when the fruiting branches left to reach a certain number of fruit spikes and the number of leaves, the top growth point will be removed. Since the top growth type of varieties do not need to pick the heart. Timely and appropriate picking can control the height of the plant, improve the fruit set rate, and promote fruit development. Plucking should leave 2 to 3 leaves on the upper side of the inflorescence, both for fruit growth and to prevent sunburn caused by direct exposure of the fruit to the sun.

3. Hanging vines: For ease of operation, it is best to use hanging vines in the arches. After the seedlings are slowed down, hang the vines in time, pull a No. 10 wire above each row of tomatoes in the north-south direction, tie each tomato with a sling and lift the plant, and hang the lower end of the sling on the wire with a movable hook that can be moved on the wire. As the plants grew, the vines were continuously led and wrapped around the slings. It is also used to pull a steel wire under the corresponding wire of the lanyard, 20cm from the ground, along with the planting line. When hanging vines will be fixed on the upper end of the lanyard wire, the lower end into 45 ~ 60 degrees, diagonal tension fixed on the following wire. Then the tomato vine is coiled directly on the sling without being tied to the stalk. This will not only avoid strangulation of the stalk, but also in the fall of the vine, the operation is very convenient, and can try to meet the tomato like semi-creeping growth habits, more conducive to tapping the high yield potential of tomatoes. When the top of the plant grows to the wire above, drop the vines in time, about 50 cm at a time.

4. Leaf thinning: combined with forking, picking should be timely removal of old leaves, diseased leaves, improve the ventilation of the lower part of the plant to reduce the occurrence of disease.

Figure 4-1 Effect of hanging and leaf thinning of tomato

5. grooming technology

Different methods of branching and hearting are used during the growth of tomato plants, resulting in a variety of different grooming methods. The most widely used grooming methods in production today are single stem grooming, multi-spike single stem grooming and continuous heart replacement grooming.

(1) Single stem grooming: keep the main stem to bear fruit, thin out the other lateral branches early, leave 3~4 spikes of fruit, and leave 2 leaves before the last inflorescence to pluck the heart. This method uses more seedlings, single plant yield is limited, but suitable for dense planting, high yield in the early stage, the total yield is also higher, suitable for early cultivation. In order to increase the number of single plant results, you can also retain a lateral branch under the fruit spike, bearing a spike of fruit plucking, become a modified single stem whole branch.

(2) multi-spike single stem branching: each plant to leave 8 to 9 spikes of fruit, 2 to 3 spikes of fruit maturity, the upper 8 to 9 spikes have flowering, you can pick the heart. Plucking when the inflorescence before leaving 2 leaves, forked to old leaves to reduce nutrient consumption. To reduce plant height, spray two times of chlormequat chloride during growth.

(3) successive head rotation: there are mainly the following three practices. One is to keep 3 spikes of fruit on the main stem plucking, leaving its strong side branches instead of the main stem, and then leave 3 spikes of fruit plucking, retaining a total of 6 spikes of fruit. The second is to make 2 head changes, leaving a total of 9 spikes of fruit, the method is

basically the same as the first. The third is a continuous heart change, when the second inflorescence of the trunk after flowering, leaving 2 leaves heart, leaving a side branch immediately below the first inflorescence as the trunk, the first side branch to bear 2 spikes of fruit after the same heart, a total of 5 heart picking, leaving 5 fruiting branches, bearing 10 spikes of fruit, after each heart picking to twist the branch, so that the fruiting branches open outward 80 to 90 degrees, later as the fruit expands, the weight increases, the fruiting branches gradually droop, each After harvesting the tomatoes, the branches should be cut off. The method requires a reduction in cultivation density, relying on a single plant with more fruit spikes and larger fruit to increase production. In addition to the lateral branches that should be retained, the remaining lateral branches are promptly knocked out when they reach 2-3 cm in length.

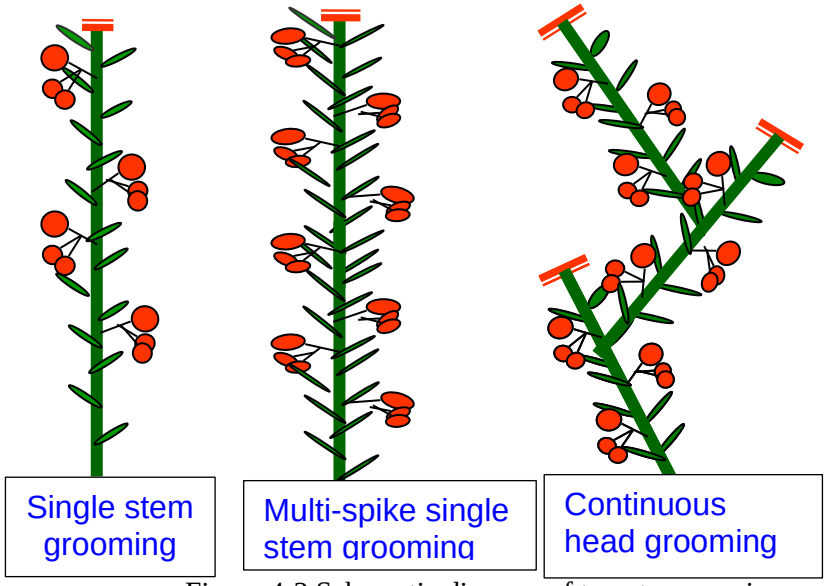

Figure 4-2 Schematic diagram of tomato grooming

(4) Whole branching precautions: Firstly, for virus disease and other diseased plants should be branched separately to avoid artificial spread of disease. Secondly, the lateral branches and other side branches under the first inflorescence, even if they are not left as fruiting branches, should not be knocked off prematurely, but generally 1-2 leaves should be left to produce nutrients and assist the growth of the main stem. But if not removed will affect the ventilation and light, should be removed in due course. Thirdly, fork picking should be done on a sunny day, not on a rainy day or when the dew is not yet dry, in order to facilitate wound healing and prevent cross-infection of pathogens.

V. Flower and fruit management

1. Flower thinning and fruit thinning

Combined with forking, picking, flower thinning and fruit thinning should be carried out to ensure that the plant has a certain number of fruit, to prevent the number of fruit too

much and cause nutritional deficiencies, so as to increase the weight of a single fruit, improve the neatness of the fruit and commerciality. Generally large-fruited varieties leave 3 to 4 fruits per spike, medium-fruited varieties should be left 4 to 5 fruits, small-fruited varieties can be left more than 5. Tomato cultivation in the flowering stage should be thinned out excess buds and deformed flowers, after fruiting should be thinned out fruit type is not neat, the shape is not standard and the same spike development too late too small fruit.

2. Flower and fruit preservation

To ensure fruit set, greenhouse tomato cultivation generally requires flower and fruit preservation. Common measures include pollination, flower and fruit drop prevention, etc.

(1) Pollination

① Bear pollination:Bear pollination can ensure a high fruit set rate without any adverse effects on the plant and fruit, while saving labor.

② Pollination by vibration: Vibrating the inflorescence is a very important pollination method in the greenhouse, a physical method, you can use an electric vibrator, the plant vibrates at least once every other day, because the ability of the stigma to receive pollen can be maintained for two days. Pollination is most effective from 11:00 a.m. to 3:00 p.m. on sunny days. Studies have shown that pollination, fruit set and fruit development are best at 70% relative air humidity. If pollination is done correctly, fruit the size of a water droplet will be seen a week after pollination. Although vibration pollination can also achieve high fruit set rates, it is very labor intensive and is not commonly used.

Figure 4-3 Vibration pollination

(3) Dipping and spraying flowers

When the temperature is below 15℃ and above 30℃ in high summer, hormones should be used to treat the flowers to prevent flower and fruit drop; growth regulating substances containing 2, 4.D or PCPA should be dipped or sprayed onto the flower stalks to promote

fruit development. Although the cost is low and a high fruit set rate can be obtained, improper use can cause damage to the plant and adversely affect the quality of the fruit. When the night temperature is lower than 10°C or the daytime temperature is higher than 35°C, the pollen of tomatoes does not develop normally and only chemical spraying can be used to promote fruit set. Or the application of too much nitrogen fertilizer, plant growth; or insufficient light, plant malnutrition, weak growth potential are prone to flower and fruit drop. These situations need to be treated with hormones.


Figure 4-4A Tomato dipping flowers Figure 4-4B Tomato spraying flowers

VI. Pest and disease management

(A) Principles of tomato pest and disease control

The principles of tomato pest control implement the plant protection policy of "prevention-oriented, integrated control" and adhere to the harmless management principle of "agricultural, physical and biological control, supplemented by chemical control". By choosing resistant varieties, cultivating strong seedlings, strengthening cultivation management, scientific fertilization, improving and optimizing field ecosystems, and creating environmental conditions conducive to the growth and development of tomatoes; giving priority to agricultural, physical, and biological control, along with the scientific and rational use of chemical control, the pests of tomatoes are controlled below the permissible economic threshold to achieve the goal of producing safe, high-quality tomatoes.

1. Agricultural control: Inhibit the occurrence of pests and diseases through scientific fertilization, facility protection and other measures.

2. Physical control: Insect net isolation, set up insect net isolation at the windbreak to reduce the occurrence of insect pests; yellow board to lure aphids, white (smoke) whiteflies, with 30 cm × 40 cm yellow board, according to the density of 30 to 40 pieces per 667m^2 hanging height and the top of the plant level or 5 to 10 cm higher.

Figure 4-5 Hanging yellow board to prevent insects

3. Biological control: actively protect the use of natural enemies to prevent and control pests and diseases, such as the control of whiteflies with Lili aphid wasps; the use of biological source pesticides such as agricultural streptomycin, new phytomycin and other biological pesticides to prevent and control pests and diseases.

4. Chemical control: according to the biological characteristics of the control object and the characteristics of the hazard, the choice of high-efficiency, low toxicity, low residue, safe pesticides, especially pesticides of biological origin, mineral origin and low toxicity pesticides, limited use of toxic pesticides, prohibit the use of highly toxic, highly toxic, high residue pesticides. At the same time, scientific mastery of the appropriate period of control, effective minimum concentration, the best control time, etc., to minimize the number and frequency of applications, and strictly comply with the safety interval. Priority is given to the fumigation method, in dry and sunny weather can also be sprayed control, pay attention to the rotation of drugs, scientific control.

(B) Common tomato disease control

1. Late blight of tomato

Tomato late blight is one of the important diseases on tomato, widely distributed and widespread, can occur in both protected areas and open fields, when the disease is light, timely control, no significant impact on production; when the disease is heavy, the disease plant rate is very high, a short period of time can cause plant leaf necrosis, significantly affecting tomato production.

The main disease symptoms: seedlings infected with dark green water-soaked spots on the leaves, quickly expanding to the petiole and stem, making it thin brown necrosis, resulting in seedlings wilted Tsutaya or inverted. Adult plant disease, mainly on the leaves, petioles

and stems, when the disease is heavy also affects the green fruit.

The disease mainly overwinters on protected tomatoes and eggplants, and can also overwinter in potato tubers, with some of the disease residues overwintering in the soil. Field onset early and late, disease development and precipitation early and late, the amount of rainfall, air humidity is directly related to high and low, the temperature in the range of the growth temperature of the disease, early and late fog, heavy dew, continuous cloudy rain disease serious occurrence. In addition, the field plant dense, low-lying terrain, partial application of nitrogen fertilizer, plant tender and appendage, the disease occurs seriously.

Prevention and treatment methods: ① Thoroughly remove diseased tissues from plants after harvest; ② Cultivate disease-free strong seedlings.③ Fertilize reasonably to avoid growth; ④ Strengthen field management; ⑤ Pharmacological control.

Figure 4-6 Tomato stems infected

Figure 4-7 Tomato late blight

2. Tomato leaf mold

Tomato leaf mildew, also known as black mold, commonly known as black hair, is a widely distributed, widespread tomato disease, mainly in protected areas, open field cultivation also occurs. This disease mainly affects the leaves, mostly from the lower and middle leaves first, followed by the abaxial leaf spots grow initially creamy yellow and then yellow-brown to purple-brown downy mildew layer, serious when multiple spots on the leaves connected to each other leading to leaf curl necrosis.

Figure 4-8 Tomato leaf mold diseased leaves

Prevention and treatment methods: ① Select disease-resistant varieties. ② Use disease-free seeds and use warm soup to soak seeds before sowing. ③Crop rotation to prevent disease. In heavily diseased plots, crop rotation should be implemented for 2 ~ 3 years to reduce the source of primary infection. ④Ecological control timely ventilation, control watering, timely drainage after watering. Avoid applying too much nitrogen fertilizer to enhance the plant's resistance to disease. Clean up the lower old yellow leaves in time to facilitate ventilation and light. ⑤ Pharmacological control.

3. Tomato gray mold

Gray mold is a common disease that is prone to occur in protected areas during the winter and spring. It causes some degree of damage to production. Tomato gray mold in the seedling and flowering stage when the formation of infestation. The leaf development site into gray-brown "V" shaped spots, later in the disease grows gray mold. After the onset of flowering or fruiting, more invasive from the petals of defeat, along the petals to the fruit infestation, the formation of gray-brown to yellow-brown necrotic spots near the fruit stalk, when the air is moist fruit rot, and gray mold layer in the diseased part, the onset of heavy rotten flowers and rotten fruit caused by a large number of a

Prevention and treatment methods: ① strengthen field management; ② strengthen the management before the rainy days (snow); ③ pharmaceutical control.

4. Tomato root rot

Tomato root rot is a worldwide soil-borne disease. Especially for facility tomato

cultivation and heavy crop plots, root rot occurs more and more frequently and gets worse every year, and in severely diseased plots, there is even an extensive dieback and crop failure. Tomato root rot is short-cycle, fast-onset and devastating, with the main symptoms being, at the tomato seedling stage, mainly at the root neck of the plant. After the onset of the disease at the root neck, there will be water stained spots, the young leaves will wilt at noon and return to normal in the morning and evening, and then the epidermis of the root neck will show water stained ring spots, the young leaves on the ground will wilt and will not return to normal in the morning and evening, the old leaves will start to turn yellow from the leaf tips, and in severe cases, the old leaves on the ground will wilt and the young leaves will wilt green, leading to the death of the plant. The symptoms are mainly on the root neck, roots and fruits. The watery spots on the root neck expand rapidly, and the fruits are brown and rotten.

Preventive measures: ① crop rotation; ② clearing the garden; ③ strengthening cultivation management: high monopoly cultivation, increased application of organic fertilizer, prevention of waterlogging, etc.; ④ pharmaceutical control.

Figure 4-11 Root rot

5. Tomato bacterial ulcer disease

Tomato bacterial ulcer disease is a common bacterial disease of tomato. The main disease symptoms: leaf susceptibility mostly starts at the leaf margin, with large spots, often with a yellow halo. Fruits produce creamy white, slightly elevated, round spots on the surface after disease onset, with the central part of the spots turning brown and forming corky protrusions, such as bird's eye, called "bird's eye spots". Many adventitious roots are produced on the surface of the stem after the disease.

Prevention and control methods: ① strengthen phytosanitary; ② crop rotation. Crop rotation with non-saccharomyces vegetables for more than 2 years; ③ select disease-resistant varieties; ④ pharmaceutical control.

Figure 4-12 Tomato bacterial ulcer disease strains and performance in the field

Figure 4-13 Tomato ulcer disease fruit

6. Tomato virus disease

Virus disease is an important disease of tomato, widely distributed and widespread, affecting production to some extent, and the onset of the disease plants seriously affects the yield and quality of tomato. The disease occurs mostly in the middle and early stages of tomato growth. Depending on the type of virus infected, tomato virus disease can be classified as tobacco mosaic virus disease, tomato fern leaf virus disease, tomato streak virus disease, tomato yellowing varicella virus disease, etc.

Preventive measures: ① select disease-resistant varieties according to local cultivation and consumption habits; ② remove weeds in and around the field before planting to eliminate insects; ③ use insect-proof nets etc. to strengthen disease prevention; ④ cultivate strong seedlings.

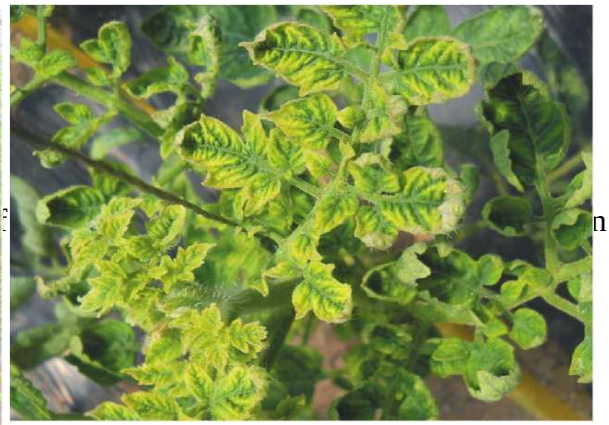

Figure 4-14 Tomato TY virus

gradually expand into a white powder spot, and join each other for the size of the white powder spot, serious when the entire leaf surface is covered by white powder, like being sprinkled with a thin layer of flour, so called white powder disease. Petiole, stem, fruit and other parts of the disease, the surface of the disease also appears white powdery mildew. The white powdery material is the disease signs (conidia and conidia).

Prevention and treatment methods: ① pay attention to the selection and breeding of disease-resistant varieties; ② it is appropriate to strengthen the temperature and humidity control in protected cultivation; ③ pharmaceutical control.

Figure 4-15 Tomato powdery mildew diseased leaves

(C) Common tomato disease control

1. Whitefly

A large number of adults and larvae dense in the back of the leaves sucking plant sap, so that the leaves wilted, receding green, yellowing and even withered, but also secrete a lot of honeydew, causing the occurrence of coal stain, covering, contaminated leaves and fruit,

seriously affecting photosynthesis, while whiteflies can also spread viruses, causing the occurrence of viruses.

Prevention and control methods: ① agricultural control: before seedling or planting, we should thoroughly remove weeds and residual plants, remove the old leaves with the early to take out of the field and burn or bury deeply; ② physical control: set up yellow boards, placed in the field to trap; ③ pharmaceutical control.

Figure 4-16 Tomato whitefly

2. Aphids

Weak insects, also known as honey bugs, putty bugs, etc., mostly belong to the weak family of Homoptera and are pests with stinging and sucking mouthparts, often clustered in leaves, young stems, flower buds, terminal buds and other parts, stinging and sucking sap, making the leaves crinkled, curled, deformed, and in serious cases, causing the withering of branches and leaves or even the death of the whole plant. The honeydew secreted by the crabs also induces coal stain, virus disease, and attracts ants.

Prevention and control methods: ① agricultural control: before seedling or planting, we should thoroughly remove weeds and residual plants, remove the old leaves with early to take out of the field and burn or bury deeply; ② physical control: set up yellow boards, placed in the field to trap; ③ pharmaceutical control.

Figure 4-17 Tomato aphid

3. spotted dive fly

It is a polyphagous pest, infesting leaves with larvae and covering them with insect channels, affecting photosynthesis, losing commercial ornamental value or reducing yield; the female adult lays eggs on the leaf to form carved spots, while the male does not form carved spots but uses them to feed.

Prevention and control methods: ① agricultural control: timely cleaning of the field and disposal; ② physical control: trapping adult insects (yellow boards coated with machine oil to attract flies); ③ pharmaceutical control.

Fig. 4-18 Tomato leaves damaged by spotted fly

4. Cotton bollworm

The larvae mainly attack the fruit, but also the buds, flowers, and even leaves and shoots. When the larvae damage the tomato fruit, they have the habit of turning the fruit, i.e. the larvae bite into the fruit and form cavities and then turn to other places, which can cause serious yield loss.

Prevention and control methods: ① Agricultural control: crop rotation and crop change

for fields planted with tomatoes in the previous year; winter irrigation and winter lingering for recreational land to kill overwintering larvae and pupae; black light or mercury lamp to trap moths in places with a large area planted with tomatoes; ② Chemical control

Figure 4-19 Cotton bollworm damage to tomato fruit

5. Tomato root knot nematode

Tomato root knot nematode is an insect pest of tomato roots. Tomato root knot nematodes mainly infest the roots of tomatoes, especially the lateral roots. The roots form many subglobular tubercles, which are interconnected like a rosary, initially white on the surface, then brown or black, with the above-ground parts showing chlorosis or yellowing, and easily shriveled or withered in dry weather. The nematodes overwinter as adults or eggs in diseased tissues or as larvae in the soil. Diseased soil and fertilizer are the main sources of disease.

Prevention and treatment methods: ① Soilless cultivation of strong nematode-free seedlings. Soilless seedling is an important measure to avoid root knot nematode damage. Because soil-free seedlings can cultivate strong seedlings to avoid early damage by root knot nematodes, and transplanted, even if the damage by root knot nematodes, the crop yield is not affected; ② use grafting technology. The use of these varieties for rootstock grafting cultivation, can effectively prevent root-knot nematode damage; ③ select resistant varieties.

Figure 4-20 Tomato root knot

(D) Common tomato disease control

1. Fruit splitting

Centered on the fruit tip, the fruit splits radially, but also has irregular lateral splits and split skin.

Cause: fruit expansion period, the fruit common skin directly exposed to light aging in advance, calcium deficiency, and excess nitrogen, phosphorus resulting in the lack of elasticity of the epidermis and sudden dryness and wetness of the soil, rapid expansion of the flesh and produce cracked fruit.

Preventive measures: reasonable fertilization, increase the application of calcium and boron fertilizer, enhance the firmness of the fruit skin, control the soil moisture, avoid watering under strong light, and avoid the fruit being exposed to strong direct light.

Figure 4-21 Tomato fruit splitting

2. Hollow Fruit

A fruit with a hollow between the skin and the flesh.

Causes of occurrence: low temperature at flowering, not normal fertilization; use of growth hormone concentration is too high; too high temperature during the young fruit period, late nutrition can not keep up.

Preventive measures: Strictly control the temperature during the flowering period of tomatoes, with an appropriate temperature of 23 to 26°C during the day and 15 to 17°C at night. Strengthen fertilizer and water management and use formula fertilization techniques. Apply growth regulators to promote fruit development. Bumblebee pollination can be used instead of hormonal pollination in production areas where available. Bumblebee pollination

can effectively reduce the incidence of hollow fruit.

Figure 4-22 Tomato hollow fruit symptoms

3. Umbilical Rot

The fruit umbilicus rots and turns dark brown with sunken tissue. Diseased fruits turn red early, but have no commercial value.

Causes of occurrence: Calcium deficiency; malfunction of water supply during fertility.

Preventive measures: Do not apply excessive chemical fertilizers, increase organic fertilizers and improve soil physical and chemical properties; try to avoid drastic changes in soil temperature and humidity. Supplement calcium fertilizer in plots prone to umbilical rot.

Figure 4-23 Tomato umbilical rot

4. Tendon Rot

The fruit surface appears to be partially brown, the fruit surface is uneven, the heart of the diseased fruit becomes hard or the flesh becomes brown, the vascular bundle becomes brown and does not turn red, and loses its commercial value. The stems and leaves of the plant have no obvious symptoms.

Occurrence causes: too much nitrogen fertilizer, lack of potassium fertilizer or soil caking and other factors caused.

Preventive measures: avoid biased application of nitrogen fertilizer, especially a one-time application of fast-acting nitrogen fertilizer should not be too much. Promote more

organic fertilizers to enhance soil permeability. Promote the transport and accumulation of photosynthetic products.

Figure 4-24 Tomato Tendon Rot

5. Tomato hormone damage

Tomato hormone damage can manifest itself on leaves, stems and fruits, with leaf damage on the surface, longitudinal leaf crinkling, stiffness, slenderness and non-spreading leaflets. The affected fruit is deformed, with a raised umbilicus and deformed fruit shape.

Occurrence factors: ① mainly due to improper use of hormones: including improper concentration, improper temperature of using hormones, repeated flower dipping and other reasons. ②Cultivation is too dense, the field sheltered depression also easily lead to hormone damage.

Prevention and treatment methods: ① strictly control the concentration of flower dipping hormone, with the change of temperature, the concentration of flower dipping to change. ② master the time to dip flowers, do not dip flowers when the temperature is too high operation. ③ dip flowers to do a good job of marking, to prevent repeated dip flowers. ④ Adopt a reasonable planting density, do not overly dense planting. ⑤ Bumblebee pollination can be used instead of hormone pollination in areas where conditions allow.

Figure 4-25 Tomato plants dipped in anther hormone poisoning

the harvesting and grading of tomatoes

(A) Tomato harvesting

Tomato fruit can be divided into four periods during ripening, namely white ripening, color change, ripening and finish ripening.

1. White ripening period: the fruit has been fully expanded, but the skin is all white-green, the flesh is hard and the flavor is poor.

Figure 4-26 Tomato white ripening period Figure 4-27 Tomato color change period

2. Color change stage: the top of the fruit starts to change from white to red or pink, the flesh s e

3 r

value,

Figure 4-28 Tomato ripening stage Figure 4-29 Tomato finish ripening stage

4. Finish ripening: Also known as the soft ripening stage, when all the tomato fruit surface turns red, the flesh becomes soft and the sugar content reaches its maximum.

As a vegetable, tomatoes are generally 40 to 50 days after flowering, the fruit reaches maturity, that is, the fruit has 3/4 of the area becomes red or yellow when the harvesting period, should be timely. Summer and autumn tomatoes than spring tomatoes coloring fast, easy to mature, easy to soften and deteriorate, near the sale of the fruit should be harvested after the start of the red; long-distance transfer, should be harvested in the white ripening period or color change period.

(B) Grading of tomatoes

The classification standards for tomatoes in China and other countries around the world are not identical, and the specific classification standards for China are shown in the table below.

Grading of tomatoes should be done in conjunction with local market and marketing needs.

Table 4-1 Tomato grading standards

Types of tomatoes	**Special grade standard**	**First-class standard**	**Secondary Standards**
Tomatoes	Consistent appearance, rounded fruit shape without ribbing (except ribbed varieties); moderate and consistent maturity; uniform color, smooth skin, full cavity, firm and elastic fruit; no damage, no cracks, no scars	The appearance is basically the same, the fruit shape is basically round, slightly deformed; ripe or slightly underripe, the maturity is basically the same, the color is more uniform; the epidermis has slight defects, the fruit cavity is full, the fruit is firm and elastic; no damage, no cracks, no scars	The appearance is basically the same, the fruit shape is basically round, slightly deformed; slightly under-ripe or slightly over-ripe, the color is more uniform; the fruit cavity is basically full, the fruit is firmer, slightly less elastic. Slightly damaged, no cracks, slight scars on the fruit skin, but the fruit commerciality is not affected
Cherry Tomatoes	Consistent appearance; moderate and consistent maturity; smooth skin, bright green calyx, no damage; firm and elastic fruit	Basically uniform in appearance; moderate and consistent in maturity; smooth skin, brighter green calyx, no damage; firmer and more elastic fruit	Basically uniform in appearance, slightly deformed; slightly under-ripe or slightly over-ripe; smooth skin, slightly wilted calyx, no damage, slightly less elastic fruit

(iii) Use of growth regulators in tomatoes during the postharvest treatment period

In order to promote the early market of tomato fruit, autumn delay, autumn and winter

crop cultivation of tomato late growth of fruit in the shed can not be normal color change, often use ethylene for tomato immature fruit ripening. Ethylene is a gas, and the commodity used in agricultural production is 40% ethylene glycol aqueous (2-chloroethyl phosphate), which is a ripening agent. Ethylene glycol enters the plant, decomposes and releases ethylene to promote fruit ripening. Its use on tomatoes is mainly to promote fruit ripening.

1. Application method: It can be used to apply pedicels, dipping fruits and coating fruits.

(1) Coating the pedicel: tomato fruit in the white ripening stage, with 300mg/kg of ethylene glycol coated on the pedicel can be.

(2) Coating the fruit: use 400mg/kg of ethylene glycol to coat the sepals of white ripe fruit flowers and their nearby fruit surfaces.

(3) immersion fruit: after harvesting during the color change period, put in 200mg/kg vinyl solution and soak for 1min, then retrieve out of 25℃ to promote red.

Ethylene use to prohibit mixing with alkaline pesticides, and can not be diluted with more alkaline water. In a sunny day when the temperature is above 20 ℃, 6 hours after the drug in case of rain, should be supplemented by spraying. Ethylene has a strong irritating effect on the eyes and skin, and has a corrosive effect on metal utensils, and releases flammable gas ethylene when heated or in contact with alkali, so it should be stored and used carefully to avoid danger.

Eight, tomatoes pulling seedlings after the greenhouse management

After pulling the tomato seedlings to remove the plastic products that cannot decay outside the shed, then spray the tomato seedlings with straw decomposer, use the straw grinder, crush the straw and turn it into the soil. The specific steps are as follows.

In the first step, loosen the tomato slings in the greenhouse (which need to be removed if they are set up with bamboo poles) so that the stems are lowered.

(b) In the second step, the straw grinder enters the shed to operate, crushing the straw directly and spinning it into the soil.

In the third step, 1.5 kg of organic material fermentation microbicides per 667 m^2 were applied through micro-sprinkler and drip irrigation, etc.

Fourth step, fastening of the trellis.

The fifth step, greenhouse closed, high temperature smothering 20-30 days, you can complete the full fermentation and decay of straw, ready for the next crop planting sit.


Figure 4-27 Tomato straw falling on vine Figure 4-28 Mechanized crushing of straw

Part V Soilless cultivation technology for tomatoes in continuous greenhouses

Soilless and efficient cultivation of tomatoes in continuous greenhouses is a method of cultivating tomatoes in continuous greenhouses without using natural soil, but using nutrient solution or solid substrate with nutrient solution, etc. The method uses continuous greenhouses for cultivation and basically enables annual production.

The method has the advantages of high yield, high efficiency and good quality, as shown by.

First, soilless cultivation can give full play to the production potential of tomatoes and can increase yields exponentially or dozens of times compared to soil cultivation.

Secondly, soil-less cultivation can save fertilizer and land, save labor and energy. When soil is planted, a lot of water and nutrients are lost and wasted, but soil-less cultivation can avoid the loss of nutrients and water, which can be fully absorbed and utilized by crops.

Thirdly, there are fewer pests and diseases, and the production process can be made pollution-free. Soil-borne diseases are a major drawback of soil cultivation, and soil disinfection is not only difficult and consumes a lot of energy, but the residues of harmful components of pharmaceuticals also endanger health and pollute the environment. Soilless cultivation can greatly reduce the impact of soil-borne diseases on tomatoes. Soil in facilities is rarely subject to rainfall, and evaporation of water and crop transpiration cause mineral elements to move from the deeper layers of the soil to the surface, leading to secondary soil salinization. Cultivation of the same crop for many years results in soil nutrient imbalance and succession disorders. Soilless cultivation avoids soil crop disorders and solves these problems at the root.

Fourth, soilless cultivation makes crops free from the soil environment and the constraints of land. Especially for some areas where there is a lack of arable land, soilless cultivation is of special significance, and many deserts, wastelands and islands can be used. It is also not restricted by space and can be used on the flat roofs of urban buildings, etc., which invariably expands the cultivation area and improves the ecological environment.

Fifth, soilless culture is clean and hygienic. The production site of soilless culture has no soil, supplying water and nutrients through pipes or special liquid supply system, and the site is clean and hygienic.

Sixth, soilless cultivation is more conducive to the modernization of agricultural production.

Soilless culture has many advantages, but there are also some shortcomings, such as large one-time investment, high operating costs, strict technical requirements, high quality requirements for managers, improper management prone to the rapid spread of certain diseases, etc., especially the poor buffering capacity of hydroponics, water and fertilizer supply can not appear any obstacles, there must be sufficient energy to ensure.

I. Types of soilless cultivation

There are many kinds of organic or inorganic substrates that can be used for soilless tomato cultivation, such as grass charcoal + vermiculite (1:1), grass charcoal + perlite (2:1), grass charcoal + slag (2:1), coconut shell fiber, charred rice husk, rockwool, waste mushroom material, etc. The choice of substrate for tomato soilless cultivation is based on the principle of taking local materials. It is also possible to do direct hydroponics, mist culture, etc. without substrates.

There are different types of substrate cultivation depending on the room, such as tank cultivation, barrel cultivation, box cultivation, etc. All of these methods can be used for soilless cultivation of tomatoes. Because tomato is a high seedling crop, it is not suitable for three-dimensional greenhouse cultivation, such as riser cultivation.

Figure 5-1 Soilless tomato bag culture Figure 5-2 Soilless tomato trough culture

Second, soilless cultivation facilities

The main facilities for tomato substrate cultivation include cultivation beds, nutrient solution circulation system and automatic control system.

(1) Cultivation beds: Cultivation beds can be brick-built troughs, polyethylene foam beds or containers such as plastic buckets and plastic boxes of suitable volume.

(2) Nutrient liquid circulation system: including nutrient liquid tank, pump, liquid filling pipeline, nutrient liquid recovery device and filtration device, etc. The nutrient solution stored in the nutrient solution tank is transported to the cultivation bed through the pump and liquid

filling pipeline; the excess nutrient solution is recycled through the recovery device. The filtering device can filter out the impurity particles in the nutrient solution to prevent clogging of the liquid filling device.

(3) Automatic control system: The more complete automatic control system includes conductivity meter, pH meter, temperature and humidity meter, light measuring device and alarm device connected with computer. The above system can monitor the concentration, pH and temperature of nutrient solution in real time, monitor the temperature and humidity of the root growth environment and the temperature, humidity and light of the greenhouse, and add liquid automatically according to the set program. Alarm device is a device that emits sound or other significant signals to alert growers when the nutrient solution or environmental factors that directly affect crop growth are far beyond the normal range value and will cause serious harm to the crop. For example, if the pH of a nutrient solution is too low, outside the allowable range, and reaches a pre-determined warning value, an alarm device will sound an alert. Simple automatic control systems sometimes include only a timer, which is set to automatically refill the solution at regular intervals.

Third, soilless culture management techniques

1. Seeding and seedling

Soilless cultivation of tomatoes is done by seedling transplanting. The specific method of seedling cultivation can be chosen from cavity tray seedling, seedling pot seedling, rockwool block seedling, etc.

2. Planting

Seedling age has a close relationship with the growth after planting. Generally, the smaller the seedling, the stronger the growth after planting and the higher the yield, but prone to deformed fruit, reduced quality, and easy to develop disease due to overgrowth. Where in the summer and autumn high temperature season seedlings, autumn delayed cultivation of autumn tomatoes or overwintering long season cultivation of tomatoes, it is desirable to plant young seedlings to maintain its necessary growth potential and increase production.

No matter what kind of soilless culture is used, the cultivation room (including cultivation bed and nutrient circulation system) and nutrient solution must be prepared before planting. When planting, we should pay attention to the temperature difference between the nursery bed and the cultivation bed should not exceed 5℃, otherwise, the temperature difference is too large and it is easy to cause damage to the roots.

The planting density depends on the crop. For one crop per year, plant 1600 to 1700 plants per 666.7 square meters; for two crops per year, plant 1800 to 2000 plants per 666.7

square meters.

Planting tomato seedlings with a portion of the stem buried in the substrate gives better anchoring and facilitates the sending of new roots from the stem buried in the substrate. Water immediately after planting. Properly planted, the plants will not wilt. Tomatoes are planted in double rows in cultivation beds, 30-40 cm apart.

3. Nutrient solution management

(1) Water quality: A variety of water sources can be used for the preparation of tomato nutrient solution. For example, river, stream, well, rain, snow, tap water or desalinated seawater. Soilless culture requires a relatively clean water source. Regardless of the water source used, the water must be completely analyzed before use in order to clarify the composition of the water. Natural water usually contains a certain amount of essential elements, especially calcium and magnesium. This content needs to be included in the preparation of the nutrient solution.

(2) Nutrient solution formula: The nutrient solution contains 16 elements necessary for tomato growth, including the massive elements carbon (C), hydrogen (H), oxygen (0), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). Trace elements include iron (Fe), manganese (Mn), boron (B), zinc (Zn), copper (Cu), molybdenum (Mo), and chlorine (Cl). Carbon is obtained from carbon dioxide in the air, hydrogen and oxygen from water, and the other 13 elements are obtained from nutrient solutions. Fertilizers used in substrate culture can be inorganic salts such as calcium nitrate, potassium nitrate, potassium dihydrogen phosphate, potassium sulfate, ammonium nitrate and chelates. Inorganic salts have high solubility, can be kept in solution in a state that plants can use, and have fast-acting characteristics. Organic fertilizers can also be used in substrate culture where they are mixed in the substrate as a base fertilizer and almost all nutrient solutions are currently formulated with inorganic salts. There are a variety of tomato nutrient solution formulations, and formulations are selected in conjunction with practical comparisons. Here are a few common formulations.

Recipe 1: Tomato nutrient solution formulation (Netherlands Institute of Greenhouse Horticulture, 1989)

Fertilizer name Dosage (mg/l)

Calcium nitrate 1216

Ammonium nitrate 42.1

Potassium dihydrogen phosphate 208

Potassium sulfate 393

Potassium nitrate 395

Magnesium sulfate 466

Formula 2: Japanese Gardening Formula Balanced Nutrient Solution

Fertilizer name Dosage (mg/l)

Calcium nitrate 950

Potassium nitrate 810

Magnesium sulfate 500

Ammonium dihydrogen phosphate 155

EDTA iron sodium salt 15 ~ 25

Boric acid 3

Manganese sulfate 2

Zinc sulfate 0.22

Copper sulfate 0.05

Sodium molybdate or ammonium molybdate 0.02

Recipe 3 Tomato nutrient solution formulation (Shandong Agricultural University)

Fertilizer name Dosage (mg/l)

Calcium nitrate 590

Potassium nitrate 606

Magnesium sulfate 492

Calcium superphosphate 680

The demand for K and Ca varies greatly in different growth stages of tomatoes. In all nutrient culture, especially in the late growth stage of tomato plants, as the fruit on the plant gradually matures from the bottom up, most of the K and Ca in the tomato leaves begin to be absorbed and moved to the fruit, so that the old leaves at the base of the plant begin to turn yellow, senesce and die. This part of the leaves should be removed in time to enhance ventilation and reduce the humidity in the lower part of the plant. Other nutrients should generally be applied in a balanced manner throughout the growth and development of the tomato plant, and micronutrients should be applied in appropriate amounts.

4. Environmental Management

(1) Temperature

According to the characteristics of tomato growth and development, the temperature management is carried out through heating system, cooling system and air release, maintaining 25~30℃ in the room during the day, 12~15℃ at night and 15~22℃ in the substrate.

(2) Light

In autumn and winter, the overall light can be improved by eliminating old, weak and

diseased plants and by timely leaf removal in low light conditions.

(3) Humidity

The air humidity in the greenhouse should be minimized in autumn and winter, maintaining a relative air humidity of 60% ~70%. The air humidity in the greenhouse should be reduced by a combination of measures such as reducing the number of watering, increasing the temperature and extending the air release time in the fall and winter.

(4) Carbon dioxide

The carbon dioxide concentration in the greenhouse should be close to the outside air carbon dioxide content by strengthening the wind release, and carbon dioxide fertilization should be adopted to increase the carbon dioxide content when available, and the suitable carbon dioxide content is 600 ~ 1000mg/kg.

Production generally uses sulfuric acid to react with ammonium bicarbonate to produce carbon dioxide. Each mu of greenhouse requires about 2.2 kg of concentrated sulfuric acid and 3.6 kg of ammonium bicarbonate per day. The application starts half an hour after sunrise and lasts for about 2 hours per day. Liquefied carbon dioxide can also be used, with about 2kg of liquefied carbon dioxide applied per mu of greenhouse per day. Carbon dioxide can also be produced by burning coal.

5. Plant adjustment, refer to the previous section on tomato field management techniques.

6. Pest and disease control

Soilless tomato cultivation eliminates soil-borne pests and diseases, especially nematodes. For above-ground pest and disease control, refer to Part V above.