

Technical Regulations for Protected Production of Netted Melon

Hongwei ZANG¹, Meiguang BI², Lizhi YU², Jinhua MOU^{2*}

1. Yantai Academy of Agricultural Sciences, Yantai 265500, China; 2. Yantai Institute of China Agricultural University, Yantai 264670, China

Abstract This paper summarized the technical regulations for protected production of netted melon in Yantai City, primarily including technical measures such as the environmental requirements of the production area, cultivation techniques, pest and disease control, harvesting, packaging, storage, waste management, and production records for netted melon grown in facilities. The technical regulations aim to standardize the protected production of netted melon and enhance the level of standardized and normative production technology.

Key words Facility; Netted melon; Production; Technical regulations

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The fruit of netted melon is in oval shape and named for its distinctive net-like patterns on its skin. It is a high-quality summer fruit highly favored by consumers^[1–2]. Netted melon has become an important local specialty agricultural product in Yantai, known for its thick, firm flesh, sweet and delicious taste, and a sugar content of 15%–17%^[3]. In 2015, it was recognized as a nationally famous, special, and new agricultural product in China. Since 1998, Liuge Town in Haiyang City introduced the ‘Luhoutian 1’ netted melon variety and began its production in solar greenhouse^[4]. Starting with Haiyang City as the main production area, cultivation gradually expanded to other regions of Yantai. Currently, the cultivated area for facility-grown netted melon in Yantai continues to increase, accompanied by continuous upgrading in cultivation facilities and continuous improvement in technical expertise. It has become a significant source of income for local farmers and has greatly promoted the development of local rural economy. However, issues such as indiscriminate fertilization, pesticide use, and soil management persist in netted melon production. The growth of netted melon requires advanced cultivation management techniques, and practices related to water, fertilizer, temperature, and pest and disease control directly impact fruit quality and marketable value^[5–7]. In order to standardize the cultivation management techniques for netted melon in controlled environments and promote the enhancement of both yield and product quality, combined with years of scientific research results, the technical regulations for the production of netted melon in controlled environments has been formulated, aiming to provide a reference for the standardized and regulated production techniques of netted melon in controlled environments.

Scope

The document specifies the requirements for the production environment, cultivation techniques, pest and disease control, harvesting, packaging, storage, transportation, disposal of production waste, and production records for netted melon grown in facilities.

Production Environment

The selected sites for constructing solar greenhouse and plastic tunnels should be characterized by elevated terrain, efficient drainage and irrigation, convenient transportation, as well as deep, loose, and fertile soil layers. The environmental conditions of the production area must comply with the requirements specified in NY/T 391.

Cultivation Techniques

Cultivation facilities

For solar greenhouse, Shandong Type IV or V models suitable for local conditions can be adopted, with construction techniques complying to the requirements of DB37/T 391. Plastic tunnels should utilize steel frame structures or galvanized thin-walled steel tube structures.

Cultivation seasons

For the early spring crop, netted melon is generally sown and nursery-raised from mid December to early January, transplanted from late January to late February, and harvested from April to June. The late autumn crop is usually planted from mid July to early August, transplanted from early August to late August, and harvested from October to November.

Variety selection

Early-maturing, high-quality, stress-tolerant, and disease-resistant varieties with distinct netting, such as ‘Wanghouthian 1’ and ‘Luhoutian 8’, which meet market demands, should be selected. For grafting, rootstock varieties specifically developed for

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Hongwei ZANG (1980–), female, P. R. China, agronomist, master, devoted to research about testing and risk assessment of agricultural products.

* Corresponding author.

netted melon grafting, such as 'Xiate', 'Yinguang', and '14F17', are chosen. The seeds must conform to the requirements of GB/T 16715.1.

Seedling cultivation

Grafted seedlings should be used. The grafted seedlings must comply with the requirements of DB37/T 1396. Alternatively, high-quality netted melon seedlings can be directly ordered from specialized seedling companies.

Land preparation, fertilization, and bedding

At 10 to 15 d before transplanting, the temperature inside the greenhouse should be raised, and irrigation should be applied to ensure soil moisture. The soil should be deeply plowed, finely harrowed, and leveled. During land preparation, the following fertilizers should be applied per hectare: 7 500 kg of commercial organic fertilizer, 750 kg of superphosphate, and 750 kg of compound fertilizer (or 450 kg of diammonium phosphate and 20 kg of potassium phosphate). Fertilization should comply with the requirements of NY/T 394. Ridges should be formed in a saddle shape, with narrow row spacing of 60 to 70 cm and wide row spacing of 100 to 110 cm. The wide furrows should be deep, while the narrow furrows should be shallow. The depth of the wide furrows should be 25 to 30 cm, and the depth of the narrow furrows should be 15 cm.

Transplanting

Transplanting should be carried out when the soil temperature at 10 cm depth in the greenhouse stabilizes above 13 °C. For the early spring crop in solar greenhouses, transplanting generally occurs from late January to early February, while in plastic tunnels, it takes place from mid to late February. Transplanting is preferably done on sunny mornings. Furrows are opened on the ridges, followed by irrigation. Seedlings are then planted at a spacing of 40 to 50 cm, with the planting depth adjusted so that the substrate surface is level with the ground. Approximately 30 000 plants are transplanted per hectare. After transplanting, the soil is covered with plastic mulch, and small arched tunnels are added to increase temperature. For the late autumn crop, younger seedlings are used for transplanting, which is preferably done on cloudy days or in the afternoon.

Post-transplanting management

Temperature After transplanting, the air temperature inside the greenhouse should be maintained at around 30 °C during the day and 17 to 20 °C at night. Before flowering and fruit setting, the temperature should be kept between 25 and 30 °C during the day and 15 to 18 °C at night. Ventilation should be performed if the temperature exceeds 35 °C. After fruit setting, the temperature should be maintained at 28 to 35 °C during the day and 15 to 18 °C at night, with a day-night temperature difference of at least 13 °C.

Pruning and vine hanging Single-stem pruning and vine hanging cultivation are recommended. Nylon or hemp strings should be used to support the vines by gently winding the main stem around the string. All lateral vines should be removed except for the fruit-

bearing vines. After fruit set on the lateral vines, most leaves and the heart should be removed, leaving two leaves above the fruit. The main vine should be topped by retaining 10 to 15 nodes above the fruit-setting node (Fig. 1).

Pollination When the female flowers at the reserved nodes open, male flowers that have bloomed on the same day are collected between 9:00 AM and 10:00 AM. The petals are removed and the pollen is gently applied from the male flowers to the stigmas of the female flowers. Alternatively, when the flowers open, the ovary is sprayed with a 200 to 240 times dilution of 0.1% CPPU (chlorfenuron) to promote fruit set.

Fruit selection and hanging A single-layer fruit setting method is adopted for netted melon. One fruit is retained per plant, typically on nodes 12 to 15 of the vine. When the young fruit reaches approximately the size of an egg, a well-shaped non-deformed piece of fruit at a suitable node position and conforming to varietal characteristics is selected. The fruit stem is tied and the fruit is hung to the level flush with the melon node.

Fertilizer and water management Watering should be controlled from after transplanting until before vine elongation. If the plants show signs of water deficiency, a small amount of water can be applied. During the vine elongation stage, compound fertilizer (15-30-15) should be applied with irrigation at a rate of 150 to 225 kg/hm². Watering should be controlled from the flowering of the female flowers at the reserved nodes until fruit setting to prevent excessive vegetative growth, which could negatively affect fruit set. After fruit set, when the fruit enters the expansion stage, enough water should be applied along with a water-soluble NPK fertilizer (10-6-40) at a rate of 150 to 225 kg/hm². A smaller amount of water can be applied again after 10 to 15 d. Watering should be stopped 10 to 15 d before harvest. Fertilization must comply with the requirements of NY/T 394. During low-temperature seasons, the water temperature used for irrigation should be similar to the room temperature. No fertilizer is applied during the net formation period.

Pest and Disease Control

Control principles

It is necessary to adhere to the plant protection policy of "prevention first, comprehensive control", and uphold the principle of "prioritizing agricultural, physical, and biological control, with chemical control as a supplementary measure".

Main diseases and pests

The main diseases of netted melon include: damping-off, downy mildew, gray mold, powdery mildew, anthracnose, gummy stem blight, and phytophthora blight. Main pests include: aphids, whiteflies, and leafminers.

Agricultural control

Disease-resistant varieties are selected, and crop rotation is practiced rationally. Grafted seedlings are used for planting. The microclimate within the greenhouse is regulated. Organic fertilizers are increased, while chemical fertilizer application is reduced. The greenhouses are cleaned to reduce the base number of pests

and diseases. Diseased leaves and melons are promptly removed and centrally destroyed. On sunny days, the greenhouses covered with film to raise the temperature inside them to 40 – 43 °C (measured at the top of the melon vines) and maintained for 1 h. After treatment, the temperature is slowly reduced to prevent downy mildew. The soil is kept moist before the treatment.



Fig. 1 Vine hanging

Physical control

Trapping using yellow sticky boards Yellow sticky boards are hung inside the greenhouses to trap and kill pests such as aphids. The specifications of the yellow sticky boards are 25 cm × 40 cm, and 450 to 600 boards are hung per hectare.

Insect-proof netting A 60-mesh nylon insect-proof net is installed at the ventilation openings of each greenhouse to effectively prevent the occurrence of pests such as aphids and whiteflies.

Biological control Natural enemies such as *Coccinella septempunctata* and *Encarsia formosa* are utilized to control aphids and whiteflies.

Chemical control

Control principles The selection and use of pesticides strictly comply with the requirements of NY/T 393. The types and dosage of pesticides applied, as well as the pre-harvest interval, are strictly controlled.

Damping-off At the early stage of disease onset, a 600 times dilution of 75% chlorothalonil wettable powder can be sprayed for control.

Downy mildew At the early stage of disease onset, a 600 times dilution of 72.2% propamocarb hydrochloride aqueous solution, or a 500 to 600 times dilution of 72% cymoxanil-mancozeb wettable powder can be sprayed for control. The application is repeated at intervals of 7 to 10 d.

Gray mold At the early stage of disease onset, a 3 000 times dilution of 50% azoxystrobin wettable powder, an 800 to 1 200 times dilution of 40% pyrimethanil wettable powder, or a 1 000 to 1 500 times dilution of 50% iprodione wettable powder can be sprayed

for control. The application is repeated at intervals of 7 to 10 d.

Powdery mildew At the early stage of disease onset, an 8 000 to 10 000 times dilution of 40% flusilazole emulsifiable concentrate, or a 1 500 to 2 000 times dilution of 10% difenoconazole water-dispersible granules can be sprayed for control. The application is repeated at intervals of 7 to 10 d.

Anthraco At the early stage of disease onset, a 1 000 to 1 500 times dilution of 65% thiophanate-methyl · diethofencarb wettable powder, or a 600 to 800 times dilution of 70% thiophanate-methyl wettable powder can be sprayed for control. The application is repeated at intervals of 7 to 10 d.

Gummy stem blight At the early stage of disease onset, a 1 000 to 1 500 times dilution of 10% difenoconazole water-dispersible granules, an 800 times dilution of 70% thiophanate-methyl wettable powder, a 500 times dilution of 64% oxadixyl-mancozeb wettable powder, or a 500 times dilution of 70% mancozeb wettable powder can be sprayed for control. Alternatively, a 100 to 150 times dilution of 70% thiophanate-methyl wettable powder can be applied by brushing directly onto the affected areas. The application is repeated at intervals of 7 to 10 d.

Phytophthora blight At the early stage of disease onset, a 600 to 800 times dilution of 72% mancozeb wettable powder, an 800 times dilution of 69% dimethomorph-mancozeb wettable powder, a 2 000 times dilution of 52.5% oxadixyl · mancozeb water-dispersible granules, or a 600 times dilution of 64% oxadixyl-mancozeb wettable powder can be sprayed for control. The application is repeated at intervals of 7 to 10 d.

Aphids, whiteflies and leafminers A 4 000 to 6 000 times dilution of 10% imidacloprid wettable powder, a 2 000 times dilution of 2.5% lambda-cyhalothrin emulsifiable concentrate, or a 2 000 times dilution of 2.5% deltamethrin emulsifiable concentrate can be sprayed for control.

Harvesting

The optimal harvest time is determined based on the pollination date, variety maturity, and characteristics such as the presence of netting on the rind, aroma, and skin color changes. Varieties whose stem abscises easily at maturity and those whose flesh softens readily after ripening are harvested slightly earlier. Harvesting is best conducted in the early morning. The fruit-bearing vine is cut, leaving a "T"-shaped stem attached to the fruit. After harvest, the fruit is stored in a cool place (Fig. 2).



Fig. 2 Mature netted melons

Packaging, Storage and Transportation

Packaging

The packaging and labeling must comply with the requirements of NY/T 1655.

Storage and transportation

During storage, products should be stored separately by variety, grade, and specification. Stacking should ensure uniform air circulation. The suitable storage temperature is 11 to 13 °C , and the suitable relative humidity is around 80% . The storage room should be cleaned and disinfected before use, and its temperature should be reduced to the suitable range. Storing together with toxic or hazardous substances is prohibited. Pre-cooling is required before transportation. The suitable transport temperature is 10 to 13 °C , and the suitable relative humidity is around 80% .

Management of Production Waste

Residual branches, diseased leaves, senescent leaves and weeds in the field are promptly cleared away and centrally subjected to harmless treatment to maintain clean field conditions. Empty pesticide bottles or bags are collected and processed according to their type.

Production Records

Detailed records are maintained, including information on the

production site’s environmental conditions, production inputs, production management, pest and disease control, product quality testing, and relevant traceability data. These records are kept for a period of no less than three years.

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