Current Status, Existing Problems and Development Strategies of Watermelon Cultivation

Yunlan JIANG *

Shangqiu Academy of Agriculture and Forestry Sciences, Shangqiu 476000, China

Abstract Watermelon is an important economic horticultural crop in China, with considerable planting-related benefits and huge market consumption demand. With the continuous advancement of large-scale and intensive cultivation, inherent drawbacks of traditional cultivation modes have become increasingly prominent. Problems including aggravated continuous-cropping obstacles, high incidence of soil-borne diseases, low standardization of cultivation, homogenized variety structure, insufficient quality stability, lagging mechanization level, and unbalanced production-marketing connection restrict the high-quality development of the industry. This paper combines the production practices in major watermelon-producing areas in China to systematically sort out the prominent difficulties existing in current watermelon cultivation. Targeted technical countermeasures are proposed from the perspectives of variety optimization, soil remediation, green plant protection, standardized cultivation, equipment upgrading and industrial-chain construction. This study aims to promote the transformation of watermelon cultivation from extensive production to high-quality, green, efficient and sustainable development, and provide theoretical reference and practical support for improving quality and efficiency of melon growers and revitalizing the characteristic fruit industry.

Key words Watermelon; Cultivation technology; Continuous-cropping obstacles; Green prevention and control; Standardized production; Industrial development

DOI: 10.19759/j.cnki.2164 – 4993.2026.04.004

Watermelon (*Citrullus lanatus*) originated in Africa and has a long history of cultivation in China, where it is a major summer fruit crop. China is the world's largest producer and consumer of watermelon, with its planting area and total output consistently ranking first globally. The watermelon industry has become a pillar industry for rural revitalization and increasing farmers' income in the Huang – Huai – Hai Plain, the sandy areas of Northwest China, and the hilly regions of South China[1]. In recent years, facility cultivation models such as facility arch tunnels, solar greenhouses, and vertical vine-hanging cultivation have been widely promoted, while new technologies such as grafted seedling production, integrated water and fertilizer management, and bumblebee pollination have been gradually adopted. These advances have effectively extended the watermelon supply period and significantly improved land productivity.

However, long-term continuous cropping year after year, scattered smallholder management models, traditional farming practices of growers, and climate change have led to the continuous emergence of various production problems. In most traditional production areas, insufficient land rotation space has resulted in progressively worsening continuous cropping obstacles. Soil-borne diseases, bacterial diseases, and viral diseases occur in complex combinations. Water and fertilizer management is often arbitrary, leading to widespread issues such as malformed fruits, fruit cracking, hollow fruits, and quality deterioration. Rising labor costs have continuously increased the pressure of traditional manual pruning and artificial pollination. Meanwhile, a limited range of varieties and the concentration of early-maturing varieties in the market have caused periodic price fluctuations. The lack of standardized production systems and lagging brand development for agricultural products have frequently led to situations where good harvests do not translate into good income[2]. Given the current practical difficulties in watermelon cultivation, identifying production pain points and establishing a comprehensive improved technology system are of great practical significance for promoting the transformation and upgrading of the watermelon industry.

Current Status of Watermelon Cultivation Development in China

Diversified cultivation models and continuous expansion of facility cultivation

Watermelon cultivation in China has developed multiple models, including open-field wheat-stubble cultivation, small-arch-tunnel early-maturing cultivation, plastic greenhouse early-spring cultivation, arch-tunnel late-autumn cultivation, and solar greenhouse long-season cultivation. In advantageous production areas such as eastern Henan in the Huang – Huai – Hai region and southwestern Shandong, early-spring arch-tunnel vertical vine-hanging cultivation of gift-type watermelons and open-field medium-to-large watermelons is predominant. Open-field plastic-mulched watermelon cultivation is developed in the northwestern production areas relying on their abundant sunlight. In southern China, rain-shelter cultivation is emphasized. Facility cultivation has broken through seasonal limitations, enabling continuous market supply from April to October. Compared with traditional ground-creeping cultivation, vertical vine-hanging cultivation increases planting density, improves fruit coloration uniformity, and significantly enhances the marketable fruit rate. Premium

Received: March 17, 2026 Accepted: August 1, 2026

Supported by Science and Technology Research Project of Shangqiu Academy of Agriculture and Forestry Sciences (20260606).

Yunlan JIANG (1978 –), female, P. R. China, master candidate, devoted to research about crop breeding and cultivation.

* Corresponding author.

small-fruited gift-type watermelons show outstanding economic advantages.

Promotion of industrialized seedling production and widespread application of grafting technology

Factory-produced plug seedling cultivation is progressively replacing traditional grower self-produced seedlings, and grafting technology using pumpkin rootstocks has been widely adopted. Grafted seedling production can alleviate the damage caused by Fusarium wilt to a certain extent and improve the low-temperature tolerance of plants, making it the most direct approach for addressing continuous cropping obstacles in old watermelon-producing areas. The number of specialized seedling enterprises continues to increase, enabling standardized supply of seedlings and reducing the risks associated with seedling raising by individual farmers.

Transformation of market demand and rising demand for high-quality premium watermelons

The consumer market is gradually shifting from "pursuing yield" to "pursuing taste, appearance and safety". Premium watermelons with thin rind, high sugar content, crisp flesh, and well-formed fruit shape command a significant market premium. The demand for differentiated varieties, such as small gift-type watermelons and specialty yellow-fleshed and rainbow-fleshed varieties, has been increasing year by year. Consumers' growing concern over pesticide residues and green production is driving the transformation of cultivation models toward green and pollution-free directions.

Diversification of production entities and dominant role of smallholder farmers

Currently, watermelon cultivation operators fall into three categories: large-scale family farms, agricultural cooperatives, and smallholder farmers. In the main production areas, smallholder farmers still dominate with independent operations. Their fragmented land parcels and small planting scales make unified technical management difficult. The proportion of large-scale new agricultural operators remains limited, restricting the speed of promotion of new technologies and new models.

Prominent Problems in Current Watermelon Cultivation

Soil degradation induced by long-term continuous cropping and prominent continuous cropping obstacles

Under limited land resources, most traditional watermelon-growing areas find it difficult to implement effective crop rotation. Continuous cultivation of watermelon for many years has induced severe continuous cropping obstacles, which is the primary challenge restricting sustainable production. Long-term excessive application of chemical fertilizers and insufficient organic fertilizer input have led to soil acidification, compaction, and decline in organic matter content. The destruction of soil aggregate structure has reduced water and nutrient retention capacity, resulting in a poor root growth environment. Harmful microorganisms such as *Fusarium oxysporum* f. sp. *niveum* and root-knot nematodes have accumulated year by year, while beneficial soil microbial populations have declined. The incidence of Fusarium wilt, gummy stem blight, and root-knot nematode damage has increased progressively. Although grafted seedlings can resist Fusarium wilt, they cannot resolve issues such as soil acidification, autotoxin accumulation, or nematode damage. Disease outbreaks continue to occur in fields that have been cultivated with grafted seedlings for many years.

Combined occurrence of diseases and pests and rising difficulty in their control

Abnormal climate, continuous cropping, and poor plant growth collectively contribute to the diversification and combined occurrence of diseases and pests. Soil-borne diseases: Fusarium wilt, gummy stem blight, and root rot occur at high incidence, and once they break out on a large scale, they can easily cause large-scale plant death[3]. Foliar and fruit diseases: Anthracnose, powdery mildew, bacterial angular leaf spot and fruit rot prevail under high temperature and high humidity conditions, and can easily break out during the rainy season if facility ventilation is not timely. Viral diseases: Whiteflies and aphids continuously transmit watermelon mosaic virus and cucumber green mottle mosaic virus, causing plant dwarfing, small leaves, and malformed fruits. Viral diseases are difficult to prevent, and there are no effective therapeutic agents after disease onset. Insect pests: *Diaphania indica*, aphids, whiteflies, spider mites, and root-knot nematodes occur alternately.

Non-standardized cultivation management and frequent fruit quality defects

Improper flowering stage management and high proportion of malformed fruits Unreasonable fruit-setting node selection—retaining the first female flower (root fruit), can easily result in fruits with large navel and thick rind. Improper pollination time, insufficient pollen viability and uneven pollination lead to asymmetric fruit development, resulting in crooked and malformed fruits. Some farmers indiscriminately use fruit-setting hormones, with imbalanced concentration control, exacerbating navel enlargement and rind thickening.

Lack of standardized water and fertilizer management Two extremes are commonly observed in production. First, excessive nitrogen fertilizer application combined with deficiencies in potassium, calcium, boron, magnesium, and other medium and trace elements leads to excessive vegetative growth, difficulty in fruit setting, and low fruit sugar content. Second, drastic fluctuations in water and fertilizer during the fruit enlargement period, such as heavy irrigation following prolonged drought, cause the rind to grow slower than the flesh, leading to fruit cracking. Many farmers irrigate and fertilize based on experience without adjusting according to crop growth stage requirements. Continuous water supply before harvest directly dilutes sugar content and reduces taste quality.

Lack of temperature and light environment control techniques In facility cultivation, low temperature and insufficient

light in early spring affect flower bud differentiation. During the fruit enlargement period, prolonged temperatures exceeding 35 ℃ in the greenhouse and excessively small diurnal temperature differences are unfavorable for sugar accumulation. Improper ventilation management results in persistently high humidity inside the greenhouse, creating favorable conditions for fungal and bacterial diseases.

Unreasonable variety structure and long variety renewal cycle

China has a large number of watermelon varieties, but the concentration of main cultivated varieties is extremely high. Most production areas have long relied on a single variety, such as early-maturing varieties including Zaojia 8424 and Meidu, leading to highly concentrated maturity periods and significant price drops due to market oversaturation. Differentiated specialty varieties are promoted on a small scale, with insufficient supply of breakthrough varieties suitable for late-autumn cultivation, crack resistance, disease resistance, and simplified cultivation. Meanwhile, variety management in some seed markets is chaotic, with counterfeit seedlings and unstable varieties entering fields and causing losses to growers. The average variety renewal cycle in China is 15 years, while many main cultivated varieties have been grown for 20 to 30 years or more, with their variety advantages gradually diminishing[4].

Low level of mechanization and light-simplified cultivation and prominent pressure of labor demand

Watermelon production involves complex procedures: seedling cultivation, transplanting, pruning and vine training, artificial pollination, harvesting, and grading, all of which are highly dependent on manual labor. In recent years, rural labor shortages and continuously rising labor costs have progressively compressed the profits of traditional manual management models. Small-scale tillage machinery, transplanting machinery, and harvesting equipment suitable for small plots and arch tunnel facilities are insufficiently adopted. Labor-saving technologies such as non-pruning cultivation and bumblebee pollination as a substitute for artificial pollination have limited coverage, constraining the sustained expansion of large-scale production.

Comprehensive Strategies for Promoting High-quality and Efficient Watermelon Cultivation

Multi-pronged measures for continuous-cropping obstacle mitigation and degraded soil remediation

Optimization of crop rotation and cropping systems Scientific crop rotation should be implemented in suitable fields, with priority given to rotation with gramineous crops such as wheat and corn, with an interval of no less than 2 years. In protected cultivation, short-term rotation of watermelon with leafy vegetables can be adopted to reduce the accumulation of soilborne pathogens. Intercropping systems of watermelon with solanaceous vegetables, peanuts, and garlic should be promoted, utilizing companion effects to suppress soilborne pests and diseases while increasing the multiple cropping index[5].

Comprehensive soil improvement Continuous application of well-fermented organic fertilizers, bio-organic fertilizers, and straw return should be implemented to increase soil organic matter content. For acidified soils, dolomite powder and quicklime should be applied to regulate soil pH. Reductive soil disinfestation and soil solarization techniques should be rationally employed to eliminate soil-borne nematodes and pathogens. Before transplanting, bioagents such as *Bacillus subtilis* and *Trichoderma harzianum* should be applied to directionally optimize the rhizosphere microecological environment.

Scientific selection of grafting rootstocks Rootstock varieties should be matched according to the cultivation system. Priority should be given to white-seeded pumpkin rootstocks with strong compatibility that do not adversely affect watermelon quality. Long-term use of a single rootstock type should be avoided, and rootstock varieties should be replaced periodically. Grafted seedlings should be implemented in conjunction with soil improvement measures, as grafting alone cannot solve all continuous cropping problems.

Establishment of a green integrated pest management system for scientific disease and pest control

Adhering to the plant protection policy of "prevention first, integrated management", priority should be given to agricultural, physical, and biological control measures, with chemical pesticides used rationally and in a standardized manner. Agricultural control: Field residual branches and rotten fruits should be thoroughly removed to reduce pest-disease residues. High-ridge plastic-mulch cultivation is adopted to lower humidity inside tunnels. Rational planting density is maintained to ensure adequate ventilation and light transmission, keep functional leaves robust, and improve photosynthetic capacity[6]. Pruning and branch removal are performed on sunny days to avoid the formation of abundant wounds. Physical and biological control: Yellow sticky cards are hung in tunnels to trap aphids and whiteflies. Predatory mites are released for the control of spider mites. Zhongshengmycin and kasugamycin are popularized for the control of bacterial diseases. Ningnanmycin and amino-oligosaccharins are applied for the prevention of viral diseases. Tetramycin and biological agents are used alternately to delay pesticide resistance[7]. Standardized chemical control: Pesticides with different action mechanisms should be rotated. The pre-harvest interval shall be strictly observed. Arbitrary tank-mixing of pesticides is prohibited.

Implementation of standardized cultivation management for steadily improving fruit quality

Standardization of seedling cultivation and fruit retention management High-quality vigorous seedlings of proper age should be selected. Female flowers should be carefully screened, discarding malformed flowers and those with thick stigmas. Priority should be given to retaining fruit from female flowers at the 10^{th} to 13^{th} nodes, with one fruit retained per plant. Artificial pollination operations should be standardized and completed during the appropriate temperature period. Bumblebee pollination should be

promoted to reduce hormone use and decrease the incidence of malformed fruits and fruits with large navels. When the use of fruit-setting regulators is necessary, the concentration should be adjusted strictly according to temperature, and the solution should be prevented from contacting the flower navel.

Establishment of a phased water and fertilizer management plan Base fertilizer should be applied with an emphasis on organic fertilizer. During the vine extension stage, water and nitrogen application should be moderately controlled to prevent excessive vegetative growth. During the fruit setting and enlargement stage, nitrogen, phosphorus, and potassium should be supplied in a balanced manner, with emphasis on potassium fertilizer supplementation. Foliar fertilizers containing calcium, boron, and magnesium should be sprayed regularly to improve rind toughness and reduce fruit cracking. Large-volume irrigation should be stopped 7 to 10 d before harvest to ensure sugar accumulation. The integration of water and fertilizer through drip irrigation under plastic mulch should be fully promoted to achieve precise application in small, frequent doses, avoiding drastic fluctuations in soil moisture.

Fine-scale regulation of greenhouse environment During the early spring seedling cultivation and transplanting stages, the minimum nighttime temperature should be maintained steadily above 14 ℃ to promote normal flower bud differentiation. During the fruit enlargement stage, daytime temperatures should be controlled at 28 – 32 ℃ and nighttime temperatures should be controlled at 16 – 20 ℃, with a large diurnal temperature difference to promote sugar accumulation. Timely ventilation and dehumidification should be carried out to maintain the relative humidity inside the greenhouse within the range of 60% to 75%.

Optimization of variety distribution and promotion of differentiated cultivation

Appropriate varieties should be selected according to the market window and cultivation system in each region. For early-spring arch tunnels, early-maturing, low-temperature-tolerant varieties should be chosen. For late-autumn cultivation, heat-tolerant, anthracnose-resistant and crack-resistant varieties should be prioritized. Early-, medium- and late-maturing varieties should be planted in combination to extend the market supply period and avoid price competition from concentrated market arrivals. Specialty varieties such as yellow-fleshed and small gift-type watermelons should be appropriately developed to create differentiated products.

Promotion of light-simplified and mechanized technologies for reducing labor costs

Bumblebee pollination should be vigorously promoted as a substitute for artificial pollination. Small rotary tillers, transplanters, and rail-type transport equipment suitable for greenhouse operations should be promoted. Research and demonstration of non-pruning simplified cultivation models should be conducted. Regional specialized and socialized service organizations should be supported to provide unified services for land preparation, seedling cultivation, plant protection, and harvesting, alleviating the labor shortage faced by smallholder farmers.

Conclusions and Outlook

At the present stage, the challenges faced by watermelon cultivation in China are systemic problems formed by the combined effects of long-term extensive cultivation models, resource constraints, and market demand shifts. Continuous cropping obstacles, increasing disease and pest pressure, non-standardized management, rising labor costs, and production-marketing imbalances are intertwined, and cannot be fundamentally resolved by relying on a single technical approach alone. The future development pathway for high-quality watermelon cultivation must adhere to soil health as the foundation, green prevention and control as the safeguard, and standardized management as the core, with continuous advancement in variety improvement, soil amelioration, and the implementation of light-simplified and mechanized technologies. Cultivation bottlenecks should be continuously broken through scientific and technological innovation. Promoting the transformation of the watermelon industry from scale expansion to simultaneous improvement of quality and efficiency can support the sustained and healthy development of the specialty fruit industry.

References

[1] WEN CC, SUN YZ, WU JX. China's watermelon and muskmelon industry during the 13th five-year plan period[J]. Agricultural Outlook, 2016, 12(5): 48 – 52. (in Chinese).

[2] XU Y. Discussion on technical pathways for improving the competitiveness of the watermelon industry[J]. China Rural Science & Technology, 2016(7): 45 – 47. (in Chinese).

[3] NIE LC, CHEN GL, ZHAO LL. Study on growth and development characteristics of grafted watermelon seedlings[J]. China Cucurbits and Vegetables, 1999(1): 7 – 10. (in Chinese).

[4] LU XQ, LIU WG, ZHAO SJ, *et al.* Analysis and suggestion on government approval data of watermelon cultivars in China[J]. China Cucurbits and Vegetables, 2015, 2802): 68 – 72. (in Chinese).

[5] WANG LB, HUI CM, ZHANG B, *et al.* The research countermeasures and the developing problems of w-melon industry in Jilin Province[J]. Jilin Vegetable, 2012(9): 36 – 38. (in Chinese).

[6] ZHONG XC. Highly effective cultural technology of seedless watermelons in Xingning region[J]. Xiandai Nongye Keji, 2010(6): 113 – 114. (in Chinese).

[7] SU SP, LIN HM, ZHANG XF, *et al.* Discussion on problems and improvement measures of autumn watermelon cultivation in Dongtai[J]. China Cucurbits and Vegetables, 2011, 24(6): 54 – 56. (in Chinese).

Editor: Yingzhi GUANG Proofreader: Xinxiu ZHU