



REVIEW ARTICLE

Feasibility, agro-climatic constraints and future prospects of blueberry cultivation in India: A critical review

Tanisha, Rehmat & Shilpa Kaushal*

Department of Agriculture, Chandigarh University, Mohali 140 413, Punjab, India

*Correspondence email - drshilpakaushalhpkv@gmail.com

Received: 25 October 2025; Accepted: 10 March 2026; Available online: Version 1.0: 11 May 2026

Cite this article: Tanisha, Rehmat, Kaushal S. Feasibility, agro-climatic constraints and future prospects of blueberry cultivation in India: A critical review. Plant Science Today. 2026;13(sp2):01–07. <https://doi.org/10.14719/pst.12415>

Abstract

Blueberries (*Vaccinium* spp.), which are commonly considered as an effective superfruit in the world, are receiving growing interest in India with their high profile of antioxidants, their functional health advantages and their new consumer acceptance. This review is a synthesis of the existing knowledge about blueberry farming in the Indian environment, with its opportunities and challenges. Agronomic constraints like acidic soils, optimum pH (4.2–5.5), shallow root systems and particular chilling requirements make it difficult to fit out very wide, but low-chill southern highbush cultivars are suitable for India. Chilling hour ranges for northern highbush (800–1200 hr), rabbiteye (300–600 hr), lowbush (> 1000 hr) and southern highbush (200–600 hr) cultivars. The climatic and biological limitations encompass heat stress and nutrient imbalances, which require integrated management in terms of precision irrigation, organic amendments and mycorrhizal associations. Pollination is another important determinant of yield and fruit quality and insect-mediated pollination is much more effective in increasing berry size, seed counts and evenness. Blueberries are also a nutritious source of anthocyanins (approximately 50–300 mg 100 g⁻¹ fresh weight), phenolic compounds (250–560 mg 100 g⁻¹ fresh weight) and vitamin C (9.7–24 mg 100 g⁻¹ fresh weight) with high amounts of dietary fibre. It has opportunities in the sale of premium fresh fruits, value-added products and possibly exporting products, but the cold-chain infrastructure is limited. Lastly, it requires a long-term sustainability of taking environmentally friendly measures, restoring the soil health and using cultivars that are resistant to climate change. Taken together, this review highlights the idea that strategic research, breeding and market integration may help blueberries to be an innovative and high-value horticultural crop in India.

Keywords: antioxidant; berry; superfruit; sustainability; *Vaccinium*

Introduction

Blueberries belong to the genus *Vaccinium* within the family Ericaceae and is appreciated worldwide due to the high antioxidant properties and other health-related advantages, such as cardiovascular, bone-strengthening and decreased risk of chronic diseases. The *Vaccinium* genus has about 400–450 species and with such broad morphological diversity and genetic variability, there is considerable crop-enhancement potential based on cutting-edge breeding and genomics (1). Blueberries are native to North America but have since spread to other markets around the world, aided by research on better cultivars, low chill varieties and characteristics like flavour, texture, shelf life and nutritional quality. Nevertheless, their superficial root system, drought prone and vulnerability to invasive pests require solutions, which are specific to a region (2). Due to the increased demand for superfruits and their recognised health benefits, the production of blueberries has been given increased attention in India. Nevertheless, due to the specific climatic and soil requirements, the profile of pests and diseases and the commercial potential of blueberries, the production of blueberries in India offers both specific challenges and opportunities.

Agronomic requirements

To thrive optimally, blueberries (*Vaccinium* spp.) require soils to be

acidic, well-drained, with a pH of 4.2 to 5.2 and high levels of organic matter. They prefer soils with the availability of absorbable iron (Fe²⁺) and demand that nitrogen be supplied as ammonium. The fact that blueberries are not usually resilient to high pH soils and that most of the Indian arable sites are featured by mineral soils means that soil amendment methods like the introduction of organic matter and acidifying agents must be employed to create the appropriate environment (3). The studies of other regions have revealed that to enhance the acidity and organic matter of the soil, pine needle mulch and peat moss or sulphur can be added; such techniques can be adapted to the Indian context (4).

Chilling requirements and climatic adaptation

There is a wide range of blueberry species that vary in terms of chilling needs and climate. The blueberries that are highbush varieties (*Vaccinium corymbosum* L.) prefer chilling periods between 800–1200 hr at temperatures below 7.2 °C; that is, at cold temperatures favoured in fermentation, which is more common in temperate areas, including the USA, Canada and parts of Europe. To increase production in warmer areas, breeders produced Southern highbush blueberries, crosses of highbush and rabbiteye varieties that needed as few as 200–600 chilling hr based on the cultivar. Not only are these hybrids adapted to low-chill areas, but they are also

more tolerant to heat during flowering and fruit set. Likewise, rabbiteye blueberries (*Vaccinium virgatum* Aiton) can be cultivated in a warm environment, requiring only 300–600 chilling hr and can be grown in areas with typical soils and temperatures found in the southeastern United States, such as those found in areas such as the southern United States (summer is hot) and northern Florida (winters are mild). Low-bush blueberries (*Vaccinium angustifolium* Aiton), on the contrary, require more than 1000 chilling hr and only thrive in extremely cold climates in the north and so cannot be easily grown in other areas (5). Winter chilling is vital in the breakage of endodormancy in floral buds. Sufficient chilling varieties of fruit and flowers have synchronised bud break, steady flowering and fruit set during the following growing season. Plants that do not meet chilling requirements develop slow and uneven bud break, long flowering, ineffective pollination and eventually low yield and fruit quality. So high chilling cultivars cannot be used in most areas of India because the winter temperatures are not low enough to satisfy these physiological necessities.

In India, it is important to choose blueberry cultivars based on chilling needs and climatic flexibility. Southern highbush cultivars (Jewel, Misty, Gulf Coast, Sharpblue) performed better than rabbiteye types (Austin, Alapaha) in mid-hill conditions of Himachal Pradesh, where winters offer moderate chilling, flower earlier, have more flowers per cluster and are earlier to harvest. This means that low-chill Southern highbush hybrids are better adapted to Indian temperate locales with shorter winters and warmer springs. Although rabbiteye cultivars have a high productivity, they are more susceptible to spring heat stress and unpredictable weather since they tend to flower later and produce later. All in all, the unpredictable weather in winter in India suits the implementation of low-chill Southern highbush and some rabbiteye varieties to produce blueberries on a sustainable basis (6).

Irrigation and water management

Due to their shallow, fibrous root system, blueberries are extremely sensitive to water stress, leading to the need for regular soil moisture levels to achieve the best growth, fruit size and yield. Practically, tensiometers measure at 10–15 centibars of matric potential of a soil, which is the pressure when the soil is at full moisture holding 10–15 centibars of water. When the matric potential of the soil is 10–15 centibars of water at 0–30 cm depth, irrigation should be applied in the active root zone (0–30 cm depth) of the soil. Equally, optimum volumetric water content (VWC) is between 18–22 % in sandy soils and 25–30 % in loamy soils. Irrigation is needed regularly but not very much because drought and waterlogging are harmful to productivity. The use of quality low-salinity water is also an important factor that should be considered since blueberries are extremely susceptible to salt build-up. Irrigation water electrical conductivity (EC_w) is ideally maintained at less than 0.7–1.0 dS m⁻¹, whereas soil electrical conductivity of the saturated paste extract (EC_e) exceeding 1.5 – 2 dS m⁻¹ could be the start of decreased plant growth and yield. Consequently, it is important to keep EC_e at or below these threshold levels for sustainable production.

Drip irrigation is viewed as the most effective among all the irrigation systems because it is the most effective in distributing the water to the root zone with less water being evaporated and risks of disease being minimised. In addition, complementary practices like organic mulching using sawdust/pine bark or straw also increase water-use efficiency by preserving soil moisture, weeding and stabilising soil temperature. In a nutshell, accurate irrigation timing,

which is dependent on soil and plant water conditions, is essential to attain sustainable yields and fruit quality in blueberry production (7).

Nutrient management

Proper fertilisation is very crucial for maximum production. On close observation of nutrient status in leaves, potassium, phosphorous and zinc content are found to be variable in different cultivars. Therefore, fertilisation is to be managed according to the requirements of the cultivar (8). For better nutrient assimilation and root health, ammonium-based nitrogen fertilisers are recommended (3).

Soil requirements

The blueberries have been reported to grow best in highly acidic soils (pH 4.2–5.5). This range is very narrow and performance of the blueberries will suffer drastically beyond it. High salinity levels (EC > 1.5 dS m⁻¹) reduces root activity and nutrient absorption, whereas sufficient organic material and desirable soil microbes maintain healthy roots and increased production (9). Plant growth is negatively affected by waterlogged conditions.

Temperature and light requirement

Northern highbush blueberries have optimum photosynthetic activity at 20–25 °C and southern highbush blueberries at 28–30 °C but higher temperatures may severely undercut photosynthesis as enzymes can be inactivated and there is more photorespiration. Photosynthesis also requires enough light, but excessive temperatures may increase the stress of light and further impair the productivity of plants (10).

Climatic adaptation and variety selection

Traditional varieties of blueberries require chilling hours which is unsuitable for much of India, where winters are mild. However, there are chances for growth in subtropical and tropical Indian regions due to the selection and development of low-chill southern highbush types and specific cultivars like Emerald, Jewel and Biloxi that are more tolerant of warmer weather (7). Southern highbush cultivars are more suited for growing in India's varied climates because they are more drought-tolerant and have anatomical adaptations, including stronger xylem and effective water transport systems (11).

Environmental and biological challenges

Dynamic changes occur in the rhizosphere microbial population throughout long-term blueberry farming and soil pH continues to be a crucial factor in determining microbial and crop health (12). Furthermore, blueberries are vulnerable to diseases such as leaf blight and under Indian conditions additional problems like anthracnose fruit rot (*Colletotrichum* spp.), Phytophthora root rot and Botrytis fruit rot have also been reported. Bio-fungicides based on *Bacillus subtilis* and host resistance strategies are two organic control solutions (13, 14). Additional hazards are brought on by climate change, particularly elevated temperatures and drought stress. Indian farmers should prioritise choosing stress-tolerant rootstocks and hardy varieties (15).

Soil nutrient imbalances

Prolonged monoculture of blueberries usually causes nutrient degradation, especially nitrogen, magnesium and iron and acidic soils enhance the build-up of aluminium (Al), thereby compromising the functionality of roots and plants. Research indicates that long-term nitrogen fertilisation and fertigation may also lead to further acidification of the soils and increase the rate of nutrient

leaching, as well as decrease yield and berry quality, highlighting the value of balanced nutrient management (16, 17). It has also been reported that excess Al in acidic soils can induce cultivar-specific physiological stress resulting in low productivity and metabolic disturbance in highbush blueberries (18). As a solution to these imbalances, integrated nutrient management strategies, such as organic amendments, biofertilisers and ericoid mycorrhizal inoculations (e.g. Soil inoculation with fungi such as *Hymenoscyphus ericae* applied during nursery preparation or at transplanting) have demonstrated potential to enhance nutrient uptake efficiency, maintenance of soil fertility and promotion of healthier plant growth (19).

Water stress and irrigation

Blueberries have a shallow root system and have a low water holding capacity which has made them very susceptible to drought as well as waterlogging. Long dry seasons lower photosynthesis and berry growth and berry roots are also affected by root rot and leaching when the soil has high water content. Recent researchers have stressed on the importance of modern irrigation methods like drip irrigation systems and pulse drip systems, which increase water availability in the root zone, enhancing fruit size and yield, as well as increasing water-use efficiency (20, 21). Additional practices like mulching not only ensure conservation of soil moisture and its temperature but also enhance organic matter in soils, reduce weeds and encourage healthy microbial population, thus providing a healthier rhizosphere environment (22, 23). Such a combination of strategies is necessary to reduce the stresses of water and continue blueberry production in altering climatic conditions (24).

Pest challenges

Growing blueberries is associated with high pest pressures and especially those of invasive and persistently occurring insects. One of the most important pests has traditionally been the blueberry maggot (*Rhagoletis mendax*) and monitoring management has been available in the form of pheromone traps to minimise fruit losses (25). Most recently, the spotted-wing drosophila (*Drosophila suzukii*) has become a significant pest because of its capacity to inflict direct yield and quality damage to ripening fruit; management is currently based on integrated methods such as sanitation, exclusion netting and push-pull management (26). Crop loss due to aphids is also through the spread of viruses, but the aphid population can be controlled by conservation biological control (such as using wildflower strips to increase predator and parasitoid abundance) (27). A combination of cultural control, biological control and prudent use of insecticides (i.e. integrated pest management (IPM)) will continue to play a vital role in ensuring a balance between pest control and ecologically sustainable systems.

Climate changes beyond heat

The problem of climate change has several effects on blueberry production that go beyond aspects of increasing temperatures. Unpredictable precipitation, particularly of heavy rainfall during harvest time, enhances fruit-splitting, decreases marketable yield (28). There is also damage to buds and flowers by sudden frost events and research has indicated that deacclimation during warm weather increases plant susceptibility to cold snaps (29). The other equally important aspect is the incompatibility of cultivar chilling needs with warmer winters resulting in delayed or uneven budbreak and incomplete fruit set. Experimental trials show that inadequate chilling can in part be replaced with hydrogen cyanamide which

enables budbreak to coincide, although a constraint exists in practice (30). The combination of all these stressors emphasises that there is an urgent need to adopt climate-resilient varieties and adaptive management of blueberry production.

Sustainability aspects in India

Organic practices, crop rotation and cover cropping can be used in improving sustainability in the horticultural systems in India especially for blueberries. One such technology with promise has been cover crop technology which has been shown to enhance soil physio-chemical characteristics, curb erosion and carbon sequestration but small holders have some barriers to their adoption, including less awareness of cover cropping benefits, shortage of quality seeds, additional labour requirements and short-term land-use constraints (31). Crop rotation, composting and green manures are also organic horticulture practices that bolster soil fertility and lower chemical dependence (32). Systems of regeneration such as integrated rotations and organic inputs are progressively seen as routes to the resilience of soils and farming livelihoods (33).

Pollination and productivity

Insect pollination is essential to blueberries' ideal fruit set and productivity. In the absence of their specialised equivalents, honeybees which are extensively distributed in India are both necessary and sufficient for commercial pollination, even though bumble bees are the ideal choice (34). Increased insect pollination is good for both yield and quality of the berry, which is significant in economic viability.

Pollination biology

The anthers of blueberry flowers are poricidal and restrict the release of pollen thus, this restricts the efficiency of pollination to insect behaviour. Although the crop is partly self-fertile, cross-pollination increases the crop and fruit quality. Comparative studies of bee species indicate bumble bees (*Bombus terrestris*) are significantly more effective pollinators than honeybees because the capability of buzz pollination enables them to extract and deposit pollen per visit. Even though honeybees can also contribute by frequently visiting flowers, their per-visit efficacy is much less. This shows that pollinator diversity especially the occurrence of bumble bees is critical towards the achievement of ideal fruit set and productivity in blueberry production (35).

Pollination efficiency and yield

Recent meta-analysis shows substantial quantitative support that insect pollination has a positive correlation on the yield and quality of blueberries. Synthesised results of various studies on highbush blueberry have shown that insect-mediated pollination had a significant positive correlation with fruit set (increases of approximately 15–40 %), berry weight (10–25 %) and seed number (20–50 %) under insect-mediated pollination compared to pollinator-excluded treatments. Their model showed that the effect sizes and explanatory power (R^2 values) were clear and high, indicating the overall positive effect of pollinator activity on the yield quantity and the traits of fruit quality. This fact makes insect pollination a decisive factor in the productivity of blueberries and underscores the need to control pollinators to maintain profitable production systems (36).

Production systems

The natural conditions necessary for blueberries are frequently

absent from Indian soils. Site-specific crop management strategies that make use of soil mapping and remote sensing may provide ways to find potentially good locations and develop orchards effectively (37). Furthermore, soil constraints may be circumvented by soilless cultivation systems, such as hydroponic and container-based techniques (38).

Nutrient requirement

The use of phosphorus and potassium is essential in the production of blueberries since it promotes the growth of roots, fruit quality and general viability in plants. However, when soils are acidic then micronutrients like iron, manganese and zinc tend to be limiting and this requires supplemental inputs. Foliar sprays are especially advised to correct deficiencies and maintain growth under Indian conditions where imbalances in nutrients tend to occur frequently (39).

Boric acid, zinc sulphate and calcium chloride foliar applied have been demonstrated to have a significant effect on increasing the productivity, fruit quality and storage of the southern highbush blueberry cv. Sharp blue in mid-hill conditions in India. Boric acid (0.1–0.2 %) as foliar spray is applied at pre-bloom, zinc sulphate (0.3–0.5 %) is applied during vegetative growth and calcium chloride (0.5–1.0 %) is applied at fruit development stage for increased fruit set and yield. These findings indicate that foliar nutrition should be applied specifically to overcome nutrient constraint and enhance preharvest success and after-harvest quality of blueberries in India (40).

Nutritional properties of blueberry

Blueberries have been known to be a nutrient rich fruit (Table 1), which offers a distinctive combination of bioactive compounds that are also known to add to the nutritional and functional value. Polyphenolic compounds are abundant in them especially the anthocyanins, which are the major group that gives them their blue colour and high antioxidant properties (41).

Table 1. Constituents and their amount in blueberry

Constituent	Reported range	Reference
Total phenolics	200–560 mg gallic acid equivalents 100 g ⁻¹ FW	(42)
Anthocyanins	50–300 mg cyanidin-3-glucoside equivalents 100 g ⁻¹ FW	(43)
Vitamin C	9.7–24 mg 100 g ⁻¹ FW	(44)
Vitamin K	~19–29 µg 100 g ⁻¹ FW	(41)
Dietary fiber	2.4–3.6 g 100 g ⁻¹ FW	(41)
Total flavonoids	150–250 mg 100 g ⁻¹ FW	(45)

FW = Fresh weight.

Market, breeding and economic opportunities

To satisfy health-conscious urban consumers, Indian growers could profit by producing blueberry types with large fruits, superior storability and high antioxidant content. Global trends show that demand for blueberries is rising. To adapt to Indian circumstances, breeding efforts should concentrate on low cold requirements, heat tolerance and disease resistance (46). Blueberries are rich in phenolic chemicals and anthocyanins, therefore having many health benefits (47).

Market opportunities in India

In India, blueberries are still a niche, high priced fruit, with most of the demand being satisfied by the imported product, mainly in large metropolitan regions like Delhi, Mumbai and Bengaluru. The rates of importation have been on the rise over the past years due to the growing consumer awareness of berries especially among urban and health-conscious population (48). Nevertheless, the local production remains small and the blueberries are mostly restricted to the high-end supermarkets, selective stores and luxury e-commerce sites. This type of market structure emphasises the aspect of scaling up production, as well as the potential of growers, who may manage to adapt the cultivation of blueberries to the conditions of India successfully (49).

In addition to fresh consumption, a huge potential is available in diversification to value-added products like jams, juices, dried blueberries, powders, nutraceuticals and functional foods. The valorisation of blueberry being reviewed suggests that products rich in anthocyanin match the current trend of urban Indian preference for functional foods (Table 2) (50).

Table 2. Postharvest and market comparison of blueberries in India vs. imports

Parameter	Domestic trials (India)	Imports (Chile/Peru to India)
Cold chain availability	< 30 % of production covered	> 90 % maintained during transit
Average shelf life	3–5 days (farm gate to local market)	12–18 days (controlled transport)
Postharvest loss %	20–30 %	< 10 %
Farm-gate price (₹ kg ⁻¹)	600–800	~900–1100 (landed import cost)
Retail price (₹ kg ⁻¹)	1000–1200	1200–1500

The comparison shows that in theory domestic blueberries can compete on price but the inability to have a stable cold chain and market connection makes it less competitive. Localised high-value niche markets (urban consumers, direct-to-retail) have been indicated to be a viable entry point by successful greenhouse trials in Maharashtra and Kerala.

Note: The data discussed in this segment has been integrated with the results of the experimental trials that were conducted by the Indian Council of Agricultural Research (ICAR) and global statistics that are available in the FAO and USDA databases.

Long-term sustainability considerations

To minimise the environmental impact of expansion, there is a need to pay attention to the sustainable practices, management of rhizosphere health, controlled use of chemicals and considering alternative substrates (12, 13). Although, organic farming is challenging due to higher chances of disease factors (e.g., root rots and leaf blights) but have higher market value and pricing (50).

The aspect of sustainability is a very important aspect of production in blueberries, especially in areas such as India where survival in a non-traditional environment is required. The ecological sustainability in the long term needs long-term strategies that reduce the impact of the environmental footprint but remain profitable. The rhizosphere health can be managed by using biofertilisers, mycorrhizal associations and organic mulches like pine needles or sawdust to restore the pH levels in soil, increase the

organic matter and aid the nutrient cycling (50). Likewise, the implementation of precision irrigation methods, such as drip irrigation and sensor-based water management is a way of ensuring efficient utilisation of resources in blueberries as the berries tend to be shallow-rooted and are drought and waterlogging-sensitive (50).

Conclusion

There are certain challenges and great opportunities in blueberry farming in India. The agronomic needs of the crop such as acid soils, exact water management and unique chilling demand, restrain its mass adoption within the conventional systems. Nevertheless, the development of low-chill southern highbush varieties, hydroponics and site-specific soil management shows great possibilities of adaptation to Indian conditions. Efficiency of pollination, balanced nutrient management and combined pest and disease control appear to be the factors that determine productivity and quality of fruits. Moreover, the outstanding nutritional and functional characteristics of blueberries coincide with the emergence of superfruits and the increasing demand of the Indian consumers for this kind of product among the health-conscious market, which opens the future opportunities of the fresh markets and value-added products. Despite the constraints in cold-chain infrastructure and steep costs of production, local high value niches and prospective export markets provide growth opportunities. To attain long-term sustainability, the focus should be on environmentally friendly cultivation methods, rhizosphere health control and climate resistant varieties. All in all, through specific studies, better growth practices and market penetration, blueberries can become a lucrative and sustainable horticultural industry in India and help in matching consumer demand with local production volumes.

Acknowledgements

The authors gratefully acknowledge the Department of Agriculture Sciences, Chandigarh University, for providing academic and technical support during the preparation of this review paper.

Authors' contributions

T contributed to paper writing, literature review structuring and final review of the manuscript. SK contributed to collecting drafts and aligning the manuscript. R contributed to paper writing and final review of the manuscript. All authors have read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used QuillBot and Gemini as AI-assisted tools to rephrase selected portions of the text. Following their use, the authors carefully reviewed and edited the content and take full responsibility for the accuracy and integrity of the publication.

References

1. Padhan A, Anushka K, Dhiman D. Crop improvement in blueberry utilising its genetic diversity: a path to sustainable berry farming. *J Mt Res.* 2025;20(1). <https://doi.org/10.51220/jmr.v20-i.1.39>
2. Rodriguez-Saona C, Vincent C, Isaacs R. Blueberry IPM: past successes and future challenges. *Annu Rev Entomol.* 2025;17(13):13. <https://doi.org/10.1146/annurev-ento-011118-112147>
3. Darnell RL, Casamali B, Williamson JG. Nutrient assimilation in southern highbush blueberry and implications for the field. *HortTechnology.* 2015;25(4):460–3. <https://doi.org/10.21273/HORTTECH.25.4.460>
4. Ahn I, Kim SH, Maeng WY, Lee IE, Chang KW, Lee JJ. Effects of soil acidity and organic matter by application of organic materials and soil mulching with pine needles for soil surface management in blueberry eco-friendly farming. *Korean J Soil Sci Fertil.* 2013;46(6):556–62. <https://doi.org/10.7745/KJSSF.2013.46.6.556>
5. Retamales JB, Hancock JF. Blueberries. Wallingford: CABI; 2018.
6. Bryla DR, Gartung JL, Strik BC. Evaluation of irrigation methods for highbush blueberry-I. Growth and water requirements of young plants. *HortScience.* 2011;46(1):95–101. <https://doi.org/10.21273/HORTSCI.46.1.95>
7. Silva SHG, Berardo MC, Rosado LR andrade R, Teixeira AFS, Duarte MH, et al. Advancing leaf nutritional characterization of blueberry varieties adapted to warm climates enhanced by proximal sensing. *Agri Engineering.* 2024;6(3):3187–202. <https://doi.org/10.3390/agriengineering6030182>
8. Zhou Y, Liu Y, Zhang X, Gao X, Shao T, Long X, et al. Effects of soil properties and microbiome on highbush blueberry (*Vaccinium corymbosum*) growth. *Agronomy.* 2022;12(6):1263. <https://doi.org/10.3390/agronomy12061263>
9. Hao L, Guo L, Li R, Cheng Y, Huang L, Zhou H, et al. Responses of photosynthesis to high temperature stress associated with changes in leaf structure and biochemistry of blueberry (*Vaccinium corymbosum* L.). *Sci Hortic.* 2019;246:251–264. <https://doi.org/10.1016/j.scienta.2018.11.007>
10. Zhang Y, Liu JB, Zhang XX. A more drought resistant stem xylem of southern highbush than rabbiteye blueberry is linked to its anatomy. *Agronomy.* 2022;12(5):1244. <https://doi.org/10.3390/agronomy12051244>
11. Che J, Wu Y, Yang H, Wang S, Wu W, Lyu L, et al. Long-term cultivation drives dynamic changes in the rhizosphere microbial community of blueberry. *Front Plant Sci.* 2022;13:962759. <https://doi.org/10.3389/fpls.2022.962759>
12. Scherm H, Krewer G. Disease management in organic rabbiteye blueberries. *Int J Fruit Sci.* 2008;8(1–2):69–80. <https://doi.org/10.1080/15538360802367661>
13. Lai J, Xiong G, Liu B, Kuang W, Song S. First report of *Coniella castaneicola* causing leaf blight on blueberry (*Vaccinium virgatum*) in China. *Plant Dis.* 2022;106:1298. <https://doi.org/10.1094/PDIS-05-21-1122-PDN>
14. Callwood J, Melmaiee K, Kulkarni KP, Vennapusa AR, Aicha D, Moore M, et al. Differential morpho-physiological and transcriptomic responses to heat stress in two blueberry species. *Int J Mol Sci.* 2021;22(5):2481. <https://doi.org/10.3390/ijms22052481>
15. Messiga AJ, Haak D, Dorais M. Blueberry yield and soil properties response to long-term fertigation and broadcast nitrogen. *Sci Hortic.* 2018;230:92–101. <https://doi.org/10.1016/j.scienta.2017.11.019>
16. Zhang X, Li S, An X, Song Z, Zhu Y, Tan Y, et al. Correction: Effects of nitrogen, phosphorus and potassium formula fertilisation on the yield and berry quality of blueberry. *PLoS One.* 2025;20(1):e0318032. <https://doi.org/10.1371/journal.pone.0318032>
17. Cárcamo MP, Reyes-Díaz M, Rengel Z, Alberdi M, Omena-García RP, Nunes-Nesi A, et al. Aluminium stress differentially affects

- physiological performance and metabolic compounds in cultivars of highbush blueberry. *Sci Rep*. 2019;9(1):11275. <https://doi.org/10.1038/s41598-019-47569-8>
18. Ammar EE, Rady HA, Khattab AM, Amer MH, Mohamed SA, Elodamy NI, et al. A comprehensive overview of eco-friendly bio-fertilisers extracted from living organisms. *Environ Sci Pollut Res*. 2023;30:113119–37. <https://doi.org/10.1007/s11356-023-30260-x>
 19. Bryla DR, Yorgey B, Shireman AD. Irrigation management effects on yield and fruit quality of highbush blueberry. *Acta Hortic*. 2009;(810). <https://doi.org/10.17660/ActaHortic.2009.810.86>
 20. Carroll JL, Orr ST, Retano A, Gregory AD, Lukas SB, Bryla DR. Weather-based scheduling and pulse drip irrigation increase growth and production of northern highbush blueberry. *HortScience*. 2024;59(5):571–7. <https://doi.org/10.21273/HORTSCI17527-23>
 21. Sullivan DM, Strik BC, Bryla DR. Evaluation of alternative mulches for blueberry over five production seasons. *Acta Hortic*. 2015;(1076):171–8. <https://doi.org/10.17660/ActaHortic.2015.1076.20>
 22. Lee SI, Choi J, Hong H, Nam JH, Strik B, Davis A, et al. Investigation of soil microbiome under the influence of different mulching treatments in northern highbush blueberry. *AMB Express*. 2021;11(1). <https://doi.org/10.1186/s13568-021-01294-6>
 23. Ru S, Sanz-Saez A, Leisner CP, Rehman T, Busby S. Review on blueberry drought tolerance from the perspective of cultivar improvement. *Front Plant Sci*. 2024;15. <https://doi.org/10.3389/fpls.2024.1352768>
 24. Rodriguez-Saona C, Vincent C, Polk D, Drummond FA. A review of the blueberry maggot fly (Diptera: Tephritidae). *J Integr Pest Manag*. 2015;6(1). <https://doi.org/10.1093/jipm/pmv010>
 25. Asplen MK, Anfora G, Biondi A, Choi DS, Chu D, Daane KM, et al. Invasion biology of spotted wing *Drosophila* (*Drosophila suzukii*): a global perspective and future priorities. *J Pest Sci* (2004). 2015;88(3):469–94. <https://doi.org/10.1007/s10340-015-0681-z>
 26. Blaauw BR, Isaacs R. Wildflower plantings enhance the abundance of natural enemies and their services in adjacent blueberry fields. *Biol Control*. 2015;91:94–103. <https://doi.org/10.1016/j.biocontrol.2015.08.003>
 27. Tasnim R, Birkel S, Calderwood L, Roberts S, Zhang YJ. Seasonal climate trends across the wild blueberry barrens of Maine, USA. *Atmosphere* (Basel). 2022;13(5):690. <https://doi.org/10.3390/atmos13050690>
 28. Deslauriers A, Garcia L, Charrier G, Buttò V, Pichette A, Paré M. Cold acclimation and deacclimation in wild blueberry: direct and indirect influence of environmental factors and non-structural carbohydrates. *Agric For Meteorol*. 2021;301–2:108349. <https://doi.org/10.1016/j.agrformet.2021.108349>
 29. Lin SY, Agehara S. Budbreak patterns and phytohormone dynamics reveal different modes of action between hydrogen cyanamide- and defoliant-induced flower budbreak in blueberry under inadequate chilling conditions. *PLoS One*. 2021;16(8):e0256942. <https://doi.org/10.1371/journal.pone.0256942>
 30. Singhal V, Ghosh J, Jinger D. Cover crop technology—a way towards conservation agriculture: a review. *Indian J Agric Sci*. 2020;90:2275–84. <https://doi.org/10.56093/ijas.v90i12.110310>
 31. Mitra S, Devi H. Organic horticulture in India. *Horticulturae*. 2016;2(4):17. <https://doi.org/10.3390/horticulturae2040017>
 32. Panday D, Bhusal N, Das S, Ghalegholabbebhahani A. Rooted in nature: the rise, challenges and potential of organic farming and fertilizers in agroecosystems. *Sustainability* (Basel). 2024;16:1530. <https://doi.org/10.3390/su16041530>
 33. Martin K, Anderson B, Minnaar C, de Jager M. Honey bees are important pollinators of South African blueberries despite their inability to sonicate. *S Afr J Bot*. 2021;137:46–51. <https://doi.org/10.1016/j.sajb.2020.09.030>
 34. Javorek SK, Mackenzie KE, Vander Kloet SP. Comparative pollination effectiveness among bees (Hymenoptera: Apoidea) on lowbush blueberry (Ericaceae: *Vaccinium angustifolium*). *Ann Entomol Soc Am*. 2002;95:345–51. [https://doi.org/10.1603/0013-8746\(2002\)095\[0345:CPEABH\]2.0.CO;2](https://doi.org/10.1603/0013-8746(2002)095[0345:CPEABH]2.0.CO;2)
 35. Eeraerts M, DeVetter LW, Batáry P, Ternest JJ, Mallinger R, Arrington M, et al. Synthesis of highbush blueberry pollination research reveals region-specific differences in the contributions of honeybees and wild bees. *J Appl Ecol*. 2023;60:2528–39. <https://doi.org/10.1111/1365-2664.14516>
 36. Panda SS, Hoogenboom G, Paz JO. Remote sensing and geospatial technological applications for site-specific management of fruit and nut crops: a review. *Remote Sens*. 2010;2:1973–97. <https://doi.org/10.3390/rs2081973>
 37. Fussy A, Papenbrock J. An overview of soil and soilless cultivation techniques-chances, challenges and the neglected question of sustainability. *Plants* (Basel). 2022;11(9):1153. <https://doi.org/10.3390/plants11091153>
 38. Ruter J. Fertilizing highbush blueberries in pine bark beds. 2009. <https://www.researchgate.net/publication/277829311>
 39. Negi ND, Upadhyay SK. Foliar nutrition induced changes in quality and storability of southern highbush blueberry cv. Sharpblue. *Indian J Hortic*. 2024;81(2):167–73. <https://doi.org/10.58993/ijh/2024.81.2.8>
 40. Kalt W, Cassidy A, Howard LR, Krikorian R, Stull AJ, Tremblay F, et al. Recent research on the health benefits of blueberries and their anthocyanins. *Adv Nutr*. 2020;11(2):224–36. <https://doi.org/10.1093/advances/nmz065>
 41. Kim JG, Kim HL, Kim SJ, Park KS. Fruit quality, anthocyanin and total phenolic contents and antioxidant activities of 45 blueberry cultivars grown in Suwon, Korea. *J Zhejiang Univ Sci B*. 2013;14(9):793–9. <https://doi.org/10.1631/jzus.B1300012>
 42. Rossi G, Woods FM, Leisner CP. Quantification of total phenolic, anthocyanin and flavonoid content in a diverse panel of blueberry cultivars and ecotypes. *HortScience*. 2022;57(8):901–9. <https://doi.org/10.21273/HORTSCI16647-22>
 43. Duan Y, Tarafdar A, Chaurasia D, Singh A, Bhargava PC, Yang J, et al. Blueberry fruit valorization and valuable constituents: a review. *Int J Food Microbiol*. 2022;381:109890. <https://doi.org/10.1016/j.jfoodmicro.2022.109890>
 44. Krishna P, Pandey G, Thomas R, Parks S. Improving blueberry fruit nutritional quality through physiological and genetic interventions: a review of current research and future directions. *Antioxidants* (Basel). 2023;12(4):810. <https://doi.org/10.3390/antiox12040810>
 45. Skrovankova S, Sumczynski D, Mlecek J, Jurikova T, Sochor J. Bioactive compounds and antioxidant activity in different types of berries. *Int J Mol Sci*. 2015;16:24673–706. <https://doi.org/10.3390/ijms161024673>
 46. Radünz AL, Herter FG, Radünz M, da Silva VN, Cabrera LDC, Radünz LL. Bud position influence the fruit quality attributes of three blueberry (*Vaccinium ashei* Reade) cultivars. *Rev Ceres*. 2022;69(2):131–8. <https://doi.org/10.1590/0034-737X202269020002>
 47. International Blueberry Organisation. Global state of the blueberry industry report. 2022. <https://www.internationalblueberry.org/>
 48. USDA Foreign Agricultural Service. Retail foods annual-India (New Delhi). 2024. <https://gain.fas.usda.gov>
 49. Durham TC, Mizik T. Comparative economics of conventional, organic and alternative agricultural production systems. *Economies*. 2021. <https://doi.org/10.3390/economies>
 50. Kim JY, Song YS, Na JK, Kim JH. Interspecific crossing between *Lilium hansonii* Leichtlin and *L. brownii* var. *colchesteri* for the breeding of new lily cultivars. *Agronomy*. 2022;12(3):621. <https://doi.org/10.3390/agronomy12030621>

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonpublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics,

NAAS, UGC Care, etc

See https://horizonpublishing.com/journals/index.php/PST/indexing_abstracting

Copyright: © The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited (<https://creativecommons.org/licenses/by/4.0/>)

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited,