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Selective Hand Pruning Does Not Reduce Yield Of ‘Farthing’ (*Vaccinium corymbosym* Interspecific Hybrids)

Z. Rubio Ames[1*], F. Rossi[1], N. Espinoza[1], and M. Faulk[1]

Additional index words: Southern highbush blueberry, pruning, fruit quality, and production

Abstract

Current pruning practices in blueberry production in the Southeastern United States exclude selective fall pruning. Most growers practice a non-selective version of mechanized summer pruning (hedging) with the primary purpose of reducing plant height. Hedging is the preferred pruning method because of its low labor requirements and cost-effectiveness. In contrast, selective fall pruning maintains a balanced vegetative and reproductive growth, but there is limited research on the effects of fall pruning or hand selective pruning on the yield and fruit quality of Southern highbush blueberry (*Vaccinium corymbosum* interspecific hybrids, SHB). This study evaluated six pruning treatments applied to the SHB cultivar ‘Farthing’: T1: ‘hedge summer/hand pruned fall’; T2: ‘hedge summer/tipping in fall’ (commercial practice); T3: ‘hand pruned fall’; T4: ‘hand pruned summer/hand pruned fall’; T5: ‘no pruning or hedging’; T6: ‘hedge and hand pruned summer/hand pruned fall’. Each treatment was tested using a complete randomized block design in a commercial farm located in South Georgia. Our results showed that selective hand pruning did not reduce total yield compared to the commercial hedging practice. However, selective hand pruning significantly increased berry size and weight while advancing ripening, which could provide growers with earlier market entry opportunities. Our study demonstrates that selective fall pruning may be a promising tool for enhancing fruit quality and optimizing early-season pricing for SHB blueberry producers in the Southeastern United States. Nevertheless, further research into cost-effectiveness and long-term impacts on the productivity of SHB is still needed.

The United States is the leading producer of blueberries, but the industry faces challenges such as adverse weather conditions, labor shortages, and rising production costs, contributing to a 4% decline in production in 2023 (291.2 metric tons) and a 6% decrease in market value ($1.03 billion) compared to 2022 (Brazelton et al. 2023; NASS-USDA 2023; NASS-USDA 2024). Additionally, the U.S. average yield (6,588 kg/ha) is considerably lower than that of major producers like Peru (12,750 kg/ha) (Brazelton et al. 2024; NASS-USDA 2024). The state of Georgia (GA), a key blueberry-producing state, has experienced significant growth in hectares in the past two decades (Brazelton et al. 2024; Haralson et al. 2023; Scherm and Krewer 2003), particularly in plantings of Southern highbush blueberries (SHB – *Vaccinium corymbosum* L. Interspecific Hybrids), due to their earlier ripening and low chill-hour requirements, which allows growers to access markets earlier and obtain higher prices (Prusa 2020; Scherm and Krewer 2003). Despite having the highest number of hectares planted, Georgia’s per-hectare production (5,328 kg/ha) is similar to the per-hectare production of Florida (4,093 kg/ha) and North Carolina (6,724 kg/ha)

[1] Horticulture Department, University of Georgia, 2360 Rainwater Road, Tifton, GA 3793-5766, USA
[*]Corresponding author e-mail address: zilfina.rubioames@uga.edu.

(NASS-USDA 2024). Overall, Southeastern (SE) states report lower per-hectare yields compared to their counterparts in the Pacific Northwest (PNW), Oregon (10,530 kg/ha) and Washington (8,710 kg/ha) benefit from genetic materials, cooler temperatures and reduced disease pressure (Brazelton et al. 2023; Brazelton et al. 2024; Cline et al. 2006; Kovaleski et al. 2015; NASS-USDA 2024; Ojiambo et al. 2007; Scherm et al. 2008). Beyond environmental factors, disparities in productivity between the PNW and the Southeastern U.S. are linked to differences in management practices, particularly pruning techniques, which play a crucial role in optimizing yield (Kovaleski et al. 2015; Strik et al. 2003, 2022; Strik and Davis 2022).

The use of selective dormant pruning has been extensively studied in blueberry production systems in the PNW (Strik et al. 2003; Strik et al. 2022; Strik and Davis, 2022). By removing older, less productive canes, selective pruning enhances the allocation of resources to the younger parts of the plant (Strik et al. 2003). In addition, selective pruning optimizes overall plant health, productivity, and architecture (Strik et al. 2003). It improves nutrient uptake efficiency, particularly for nitrogen reserves (N), which tend to accumulate more in the crown (Strik et al. 2003). Selective-pruned blueberry plants exhibit higher foliar concentrations of essential nutrients such as potassium (K) and phosphorus (P) compared to speed-pruned, where one or two of the least productive canes are removed from the base, or unpruned plants (Strik et al. 2003). Moreover, selective pruning helps reduce heavy crop loads, improving the concentration of nutrients like boron (B) and calcium (Ca) within the plant (Arrington and DeVetter 2017; Strik et al. 2019; Strik and Davis, 2022). In addition to its nutritional benefits, selective dormant pruning promotes a balanced development of vegetative and reproductive growth, enhances yields and fruit quality but also increases machine harvest efficiency, and enhances concentrated ripening, thereby could reducing labor costs during the harvest season (Karimi et al. 2017, Strik et al. 2003, Strik and Davis 2022).

Growers in the Southeast typically employ mechanized, non-selective post-harvest hedging to manage plant height while minimizing labor expenses (Austin 1997, Krewer et al. 2004). Summer hedging specifically refers to mechanically cutting the top of the blueberry canopy to a uniform height after harvest. Hedging is often followed by tipping, a practice that involves pinching or cutting the tips of young, actively growing shoots to promote branching and improve fruit production. Although hedging is cost-effective, it can lead to excessive shoot growth, resulting in a denser canopy that increases vulnerability to pests and diseases while diminishing the effectiveness of pest control sprays (Schöneberg et al. 2020). Furthermore, the heavy crop load on less vigorous lateral shoots, a consequence of hedging, may deplete carbohydrate reserves, ultimately reducing yields in subsequent years (Karimi et al. 2017; Kovaleski et al. 2015). The longevity of Southern highbush (SHB) plants also poses challenges to profitability, as full commercial productivity generally peaks by year four and starts to decline by year seven (Retamales and Hancock, 2018), forcing producers to replant around year ten to remain competitive. Thus, while hedging may provide short-term cost savings, it can negatively impact productivity and economic returns over the lifespan of SHB blueberry systems.

This study aims to identify a selective pruning technique that can enhance productivity in the Southeast blueberry production systems without compromising yield and fruit quality.

Materials and Methods

Plant material and treatments. The study was conducted on a commercial blueberry farm in Alma, Georgia, U.S. (lat. 31°64'47.5"N, long.

82°58'60"W) over the 2022-2023 and 2023-2024 seasons. The cultivar used was the SHB 'Farthing'. Plants were established in 2019 on raised beds amended with pine bark, the spacing was 4 x 0.9 m in north-south-oriented rows. Plants had a very dense canopy and had not been previously hand pruned. The soil type was loamy sand. During the growing seasons, the plants were irrigated using a drip system, and granular fertilizer (13K-6P-6K) was applied twice a year in March and June at a rate of 505 kg/ha.

The experiment was set up as a Randomized Complete Block Design, with six distinct pruning treatments (Table 1) and three replicates for each treatment. Each replicate consisted of an experimental unit with five plants. The treatments and experimental plots remained unchanged across both years of the study, ensuring consistency in plant responses. Specifically, unpruned plants remained unpruned, while pruned plants received the same designated treatment in both years. To maintain uniformity in the pruning, the same individual performed the pruning on the designated plots each year. Summer pruning treatments were applied on August 9, 2022, and August 7, 2023, while fall pruning treatments were conducted on November 28, 2022, and December 5, 2023. The time required to prune each plot was recorded for both summer and fall treatments.

Phenological assessments. Growth stages were evaluated using a modified version of the Michigan State University growth stages chart (Figure 1). Flower bud and fruit development were monitored weekly on three shoots from the three central plants. Flower buds were assessed from January to March, while berry development was observed from April to May.

Harvest and fruit quality. In each experimental plot, three middle plants were hand-harvested weekly. The total yield from these three plants was calculated and then divided to determine the yield per individual plant. Berry weight was determined by weighing 100 g of berries using an analytical scale (OHAUS, RANGER 3000, USA) and counting the number of berries in the 100 g to obtain an average berry weight. At every harvest, a random subsample of 25 berries was taken to measure berry size and firmness using a FruitFirm® 500 (CVM Inc., Pleasanton, CA, USA). For fruit quality assessments, the berries were blended and

Table 1. Pruning treatments applied to the variety 'Farthing', established in 2019 in Alma, Georgia, USA.

Treatment	Description
T1	Hedge summer/hand pruned fall
T2	Hedge summer/tipping in fall (commercial practice)
T3	Hand pruned fall
T4	Hand pruned summer/hand pruned fall
T5	No pruning or hedging
T6	Hedge and hand pruned summer/hand pruned fall

homogenized with a PowerGen 500 homogenizer (Fisher Scientific, Schwerte, Germany). The resulting slurry was centrifuged at 4 °C and 9,000 rotations per minute using a Sorvall X4R Pro-MD centrifuge (Thermo Scientific, Osterode, Germany). The supernatant was then filtered through cheesecloth, stored in plastic vials, and frozen at -18 °C to be analyzed at a later point. Titratable Acidity (TA) was quantified using 0.1 mol L^{-1} NaOH with a titrator (916 Ti-Touch, 915 KF Ti-Touch, and 917 Coulometer with 810 Sample Processor, Metrohm AG, Herisau, Switzerland). TA results are expressed as citric acid equivalents (g citric acid per 100 mL of fresh juice). Total Soluble Solids (TSS) were analyzed with an Atago 3810 PAL-1 digital refractometer (Tokyo, Japan), and results were reported as degrees Brix.

Statistical analysis. All statistical analyses were conducted using JMP software (ver. 18, SAS Institute, Inc., Cary, NC, USA). A one-way ANOVA at $\alpha = 0.05$ was performed to measure the effect of each pruning treatment on productivity and fruit quality. Each year was analyzed separately. Mean separation was conducted using Tukey's test at $\alpha = 0.05$ to identify significant differences among treatments.

Yield per plant data, expressed in grams, were $\log_{10}$ transformed to stabilize variance across treatment combinations and ensure normally distributed residuals, meeting ANOVA assumptions.

Results and Discussion

Total yield. Over the two years of data collection, plants that were hedged in summer and hand pruned in fall (T1), as well as those hedged and hand pruned in both summer and fall (T6), had a lower yield compared to the commercial practice (T2) and the no pruning or hedging treatment (T5) (Figure 2). The total yield of the plants that were hand pruned only in fall (T3) or in summer and fall (T4) was not significantly affected by the selective hand pruning treatments across both seasons, compared to the commercial pruning practice (T2). Hand pruning does not necessarily reduce overall fruit production. Instead, it may optimize the balance between yield and fruit size, offering a viable alternative to commercial pruning practices (Strik et al. 2003).

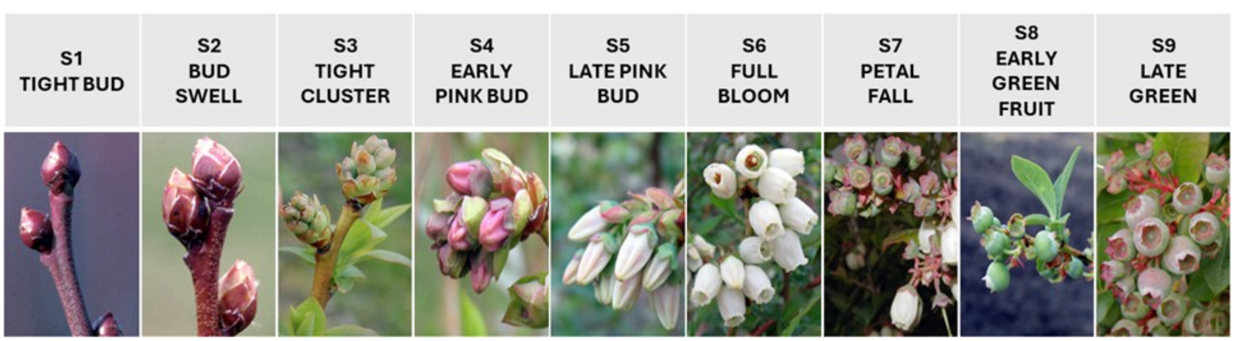

Figure 1. Modified growth stages of blueberry, adapted as a reference for interpreting the study results (see www.canr.msu.edu; [accessed on 11.12.2024]).

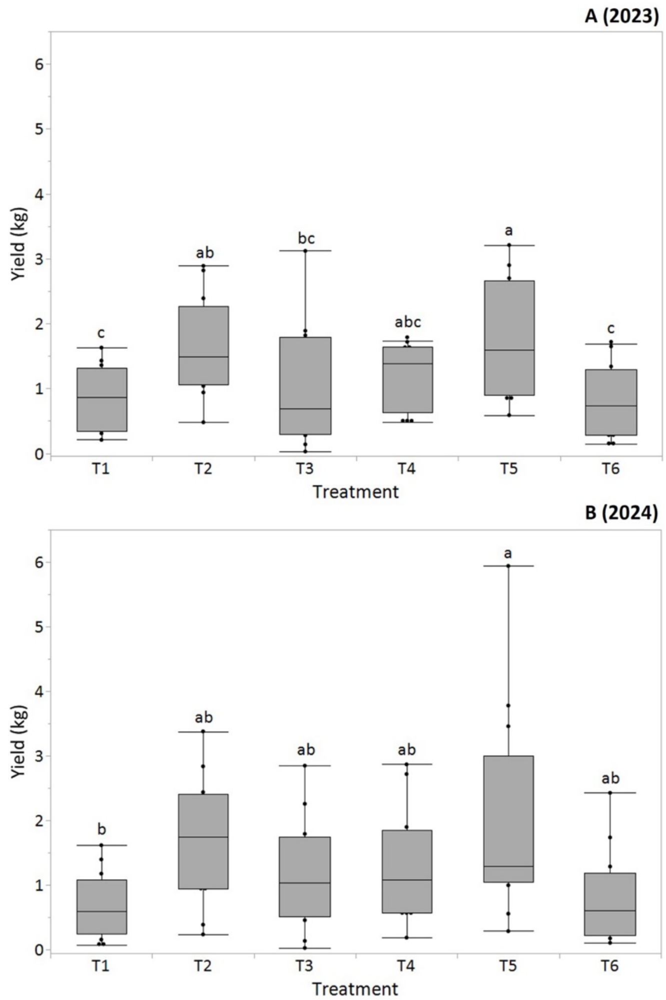

Figure 2. Total average yield (kg) per treatment obtained in each pruning treatment applied to 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Total average yield (kg) per treatment (three plants) obtained in each pruning treatment applied in 2023. (B) Total average yield (kg) per treatment obtained in each pruning treatment applied in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

Berry size. In 2023, berries from plants that were hand pruned in both summer and fall (T4) and those hedged in summer and hand pruned in fall (T1) were significantly larger than those from the commercial practice (T2) and the no pruned or hedged treatment (T5) (Figure 3A). Plants that are not properly pruned produce an excessive number of flower buds and berries leading to smaller, lower-quality berries (Jansen 1997). Plants that were hedged and hand pruned in both summer and fall (T6) produced berries similar in size compared to those in T1 and T4, further emphasizing the benefits of selective pruning (Figure 3A).

The positive effects of selective pruning became more pronounced in 2024 (Figure 3B), indicating a strong correlation between hand pruning and increased berry size. Plants that were hand pruned in the fall (T3) achieved the largest berry size, confirming that selective hand pruning contributes to greater berry size without reducing yield, especially in 'Farthing', which is a high-yielding variety.

Increasing berry size, up to 15.3 mm, could enable producers to secure premium pricing, as the market prefers larger berries (Brazelton et al. 2022; Brazelton et al. 2023; Brazelton et al. 2024).

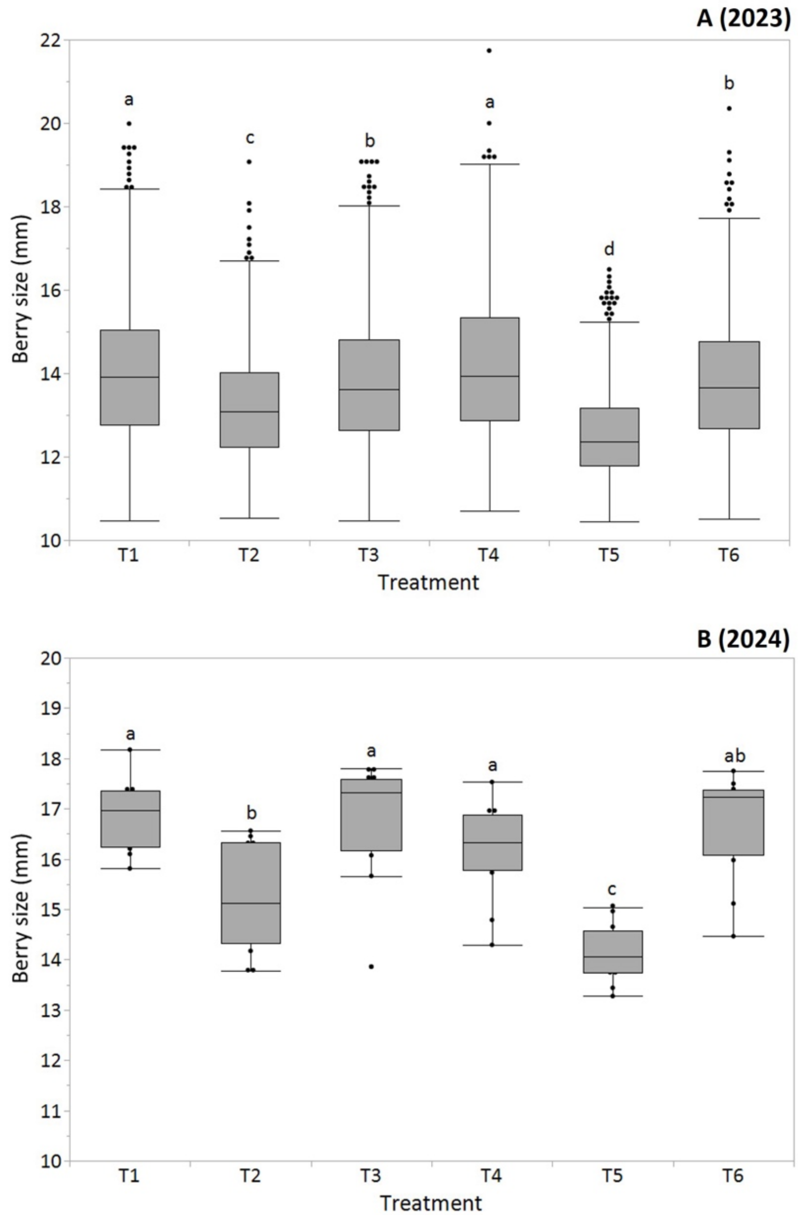

Figure 3. Average berry size (mm) in 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Average berry size (mm) in 2023. (B) Average berry size (mm) in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

Berry weight. Berry weight was also higher in plants that were hand pruned in the summer and fall (T4), hand pruned in the fall (T3), hedged in the summer and hand pruned in the fall (T1) and hedged in summer and hand pruned in summer and fall (T6) (Figure 4). In both seasons, the lowest berry weight was obtained from plants under the commercial practice treatment (T2), and from plants that were no pruned or hedged (T5). Similar findings were obtained on the SHB cultivar 'Misty', and on northern highbush varieties 'Bluecrop' and 'Berkeley' when left unpruned (Kang et al. 2018; Strik et al. 2003). Conversely, selective hand pruning treatments in either summer or fall (T4) consistently produced heavier berries.

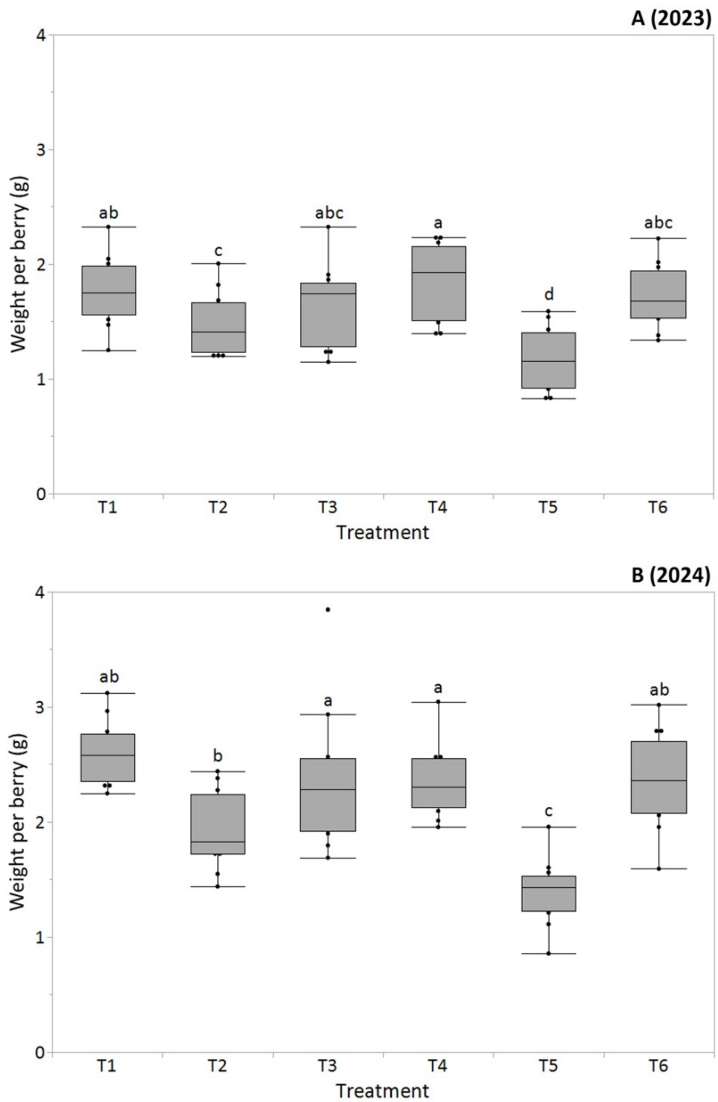

Figure 4. Average berry weight (g) obtained in each pruning treatment applied to the cultivar 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Average berry weight (g) obtained in each pruning treatment applied in 2023. (B) Average berry weight (g) obtained in each pruning treatment applied in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

The lower berry weight observed in the commercial practice treatment (T2) and the no pruned or hedged treatment (T5) can be attributed to excessive vegetative growth and a heavy crop load, which dilute carbohydrate allocation across numerous growing points (Hirzel et al. 2023; Karimi et al. 2017; Kovaleski et al. 2015).

These results confirm that fall pruning is an effective management strategy to increase berry weight without compromising yield. By reducing crop load and increasing light penetration within the canopy, fall pruning enhances photosynthetic efficiency and allows for greater carbohydrate allocation to the fruit during its developmental stages (Godoy et al. 2018; Kang et al. 2018; Kumarihami et al. 2021).

Blooming and fruit ripening. Pruning methods influenced both blooming and fruit ripening in the two years of the study (Figure 5). Among the treatments, plants that were hand pruned in the fall (T3) consistently reached full bloom (%S6) earlier than those from T2 (commercial hedging practices), T1 (hedged in summer followed by hand pruned in the fall), and T6 (hedged and hand pruned in the summer and hand pruned in the fall). In addition, plants from T3 (hand pruned fall) exhibited advanced fruit coloring and ripening, suggesting that hand pruning in the fall advances berry ripening, which can allow growers to achieve an early harvest. By creating a more open canopy, selective hand pruning enhances light penetration and reduces internal shading, promoting uniform berry ripening (Lee et al. 2015; Strik et al. 2003). Blueberries grown under a shaded environment experienced a delayed ripening of about 10-16 days (Godoy et al. 2018; Lee et al. 2015). Consequently, improved light exposure through selective pruning could reduce the number of picks in a blueberry operation, lowering harvesting costs, and improving machine harvest efficiency (Strik et al. 2003).

On the contrary, plants from treatments T1, T2, and T6, all of which incorporated summer hedging, exhibited a delay in bloom. Bloom delay could be beneficial in mitigating the risk of spring freezes (Smith 2019). However, none of the treatments advanced berry ripening, as observed in T3.

Seasonal yield patterns. The data across 2023 and 2024 indicate that the type of pruning and timing influence blueberry yield patterns (Figure 6). While overall yield differences between treatments were not consistently significant across all harvest dates, plants that were hand pruned in the fall (T3) and those hand pruned both in the summer and in the fall (T4) tended to have higher yields early in the season. Thus, confirming the improved light penetration in the canopy, which led to a faster and more uniform fruit ripening (Godoy et al. 2018; Kang et al. 2018; Kumarihami et al. 2021). In contrast, plants from the commercial practice treatment (hedging in summer and tipping in fall – T2) had a delayed peak in yield, which was observed in mid-season, indicating that hedging potentially postpones fruit ripening, possibly due to reduced light exposure. The control treatment (no pruning or hedging – T5) achieved the highest mid-season yields in both years, suggesting that the absence of pruning increases fruit load but also delays ripening and promotes uneven fruit ripening, along with reductions in both berry size and weight (Figures 3, 4, 5).

Fruit quality. Pruning affected fruit quality parameters, but it was not consistent in the two years of data collection. In 2023, berry firmness (Figure 7) was significantly lower for berries harvested from plants under the commercial treatment (T2) compared to the berries harvested from plants under the hedged summer and hand pruned fall treatment (T1). Our results align with observed berry size differences, in which plants from the T1 produced larger berries, showed higher firmness, while T2, with smaller berries, had lower firmness (Figure 3A). However, in 2024, despite variations in berry size (Figure 3B), no significant differences in firmness were found among the different pruning treatments (Figure 7B). The lack of variation could be attributed to the increased frequency of rainfall events in Alma, GA, particularly during the harvest season. In addition, over-cropped plants exhibit lower calcium and boron levels, which can negatively impact berry firmness (Arrington and DeVetter 2017; Strik et al. 2019; Strik and Davis 2022). However, nutrient content was not assessed in this study. Environmental and physiological factors likely had a more dominant effect on firmness in 2024, obscuring any size-related influences.

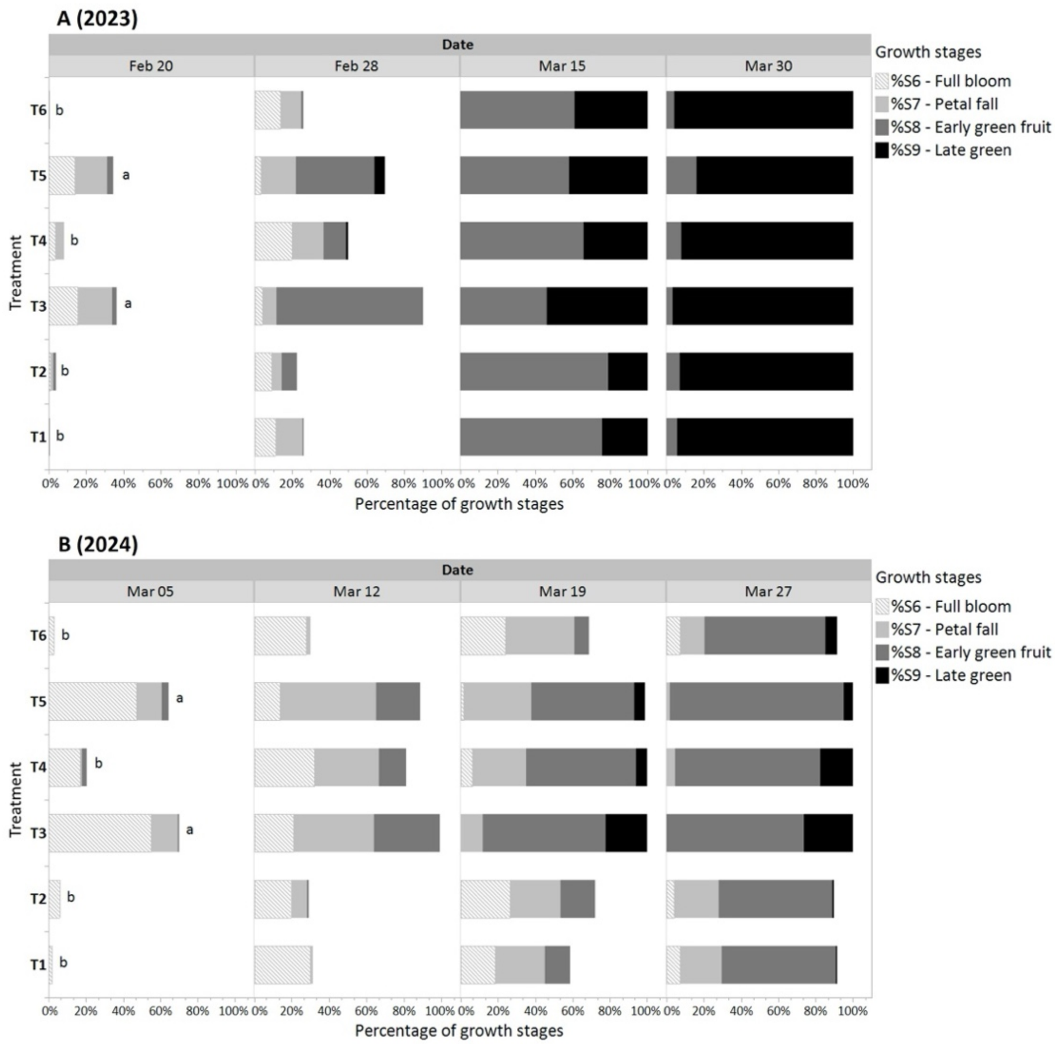

Figure 5. Percentage distribution of growth stages for each pruning treatment applied to 'Farthing', recorded by sampling date across two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Percentage of growth stages for each pruning treatment in 2023. (B) Percentage of growth stages for each pruning treatment in 2024. Growth stages are defined as follows: %S6 – Full bloom; %S7 – Petal fall; %S8 – Early green fruit; %S9 – Late green fruit according to the Michigan State Growth Stage Scale (see www.canr.msu.edu). Different lowercase letters indicate statistically significant differences between treatments in reaching %S6 earlier in the season ($p<0.05$, Tukey-Kramer all-pairs test).

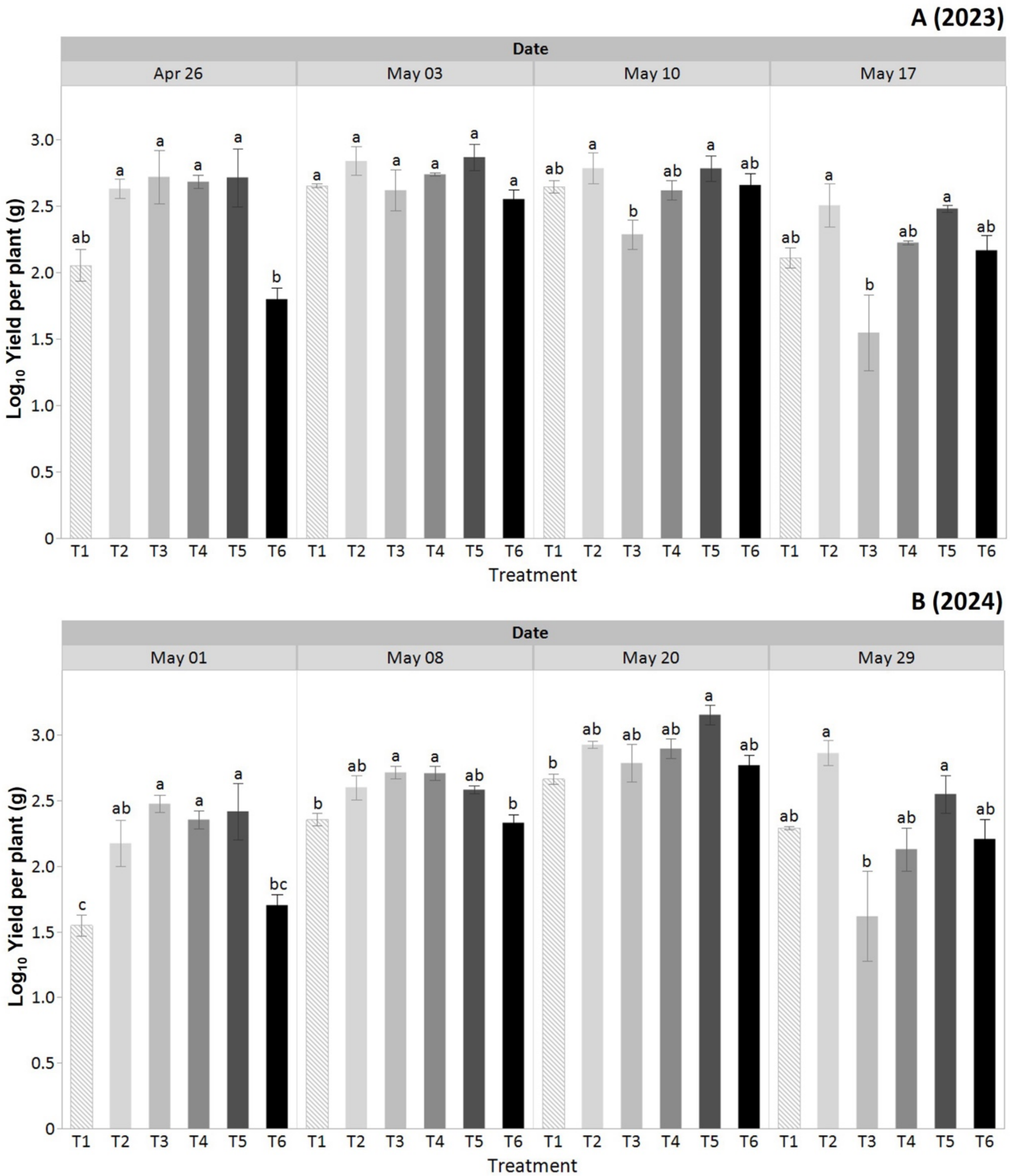

Figure 6. Log$_{10}$-transformed yield per plant (g) per each pruning treatment applied to the 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Yield per plant (g) per each pruning treatment applied in 2023. (B) Yield per plant (g) per each pruning treatment applied in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

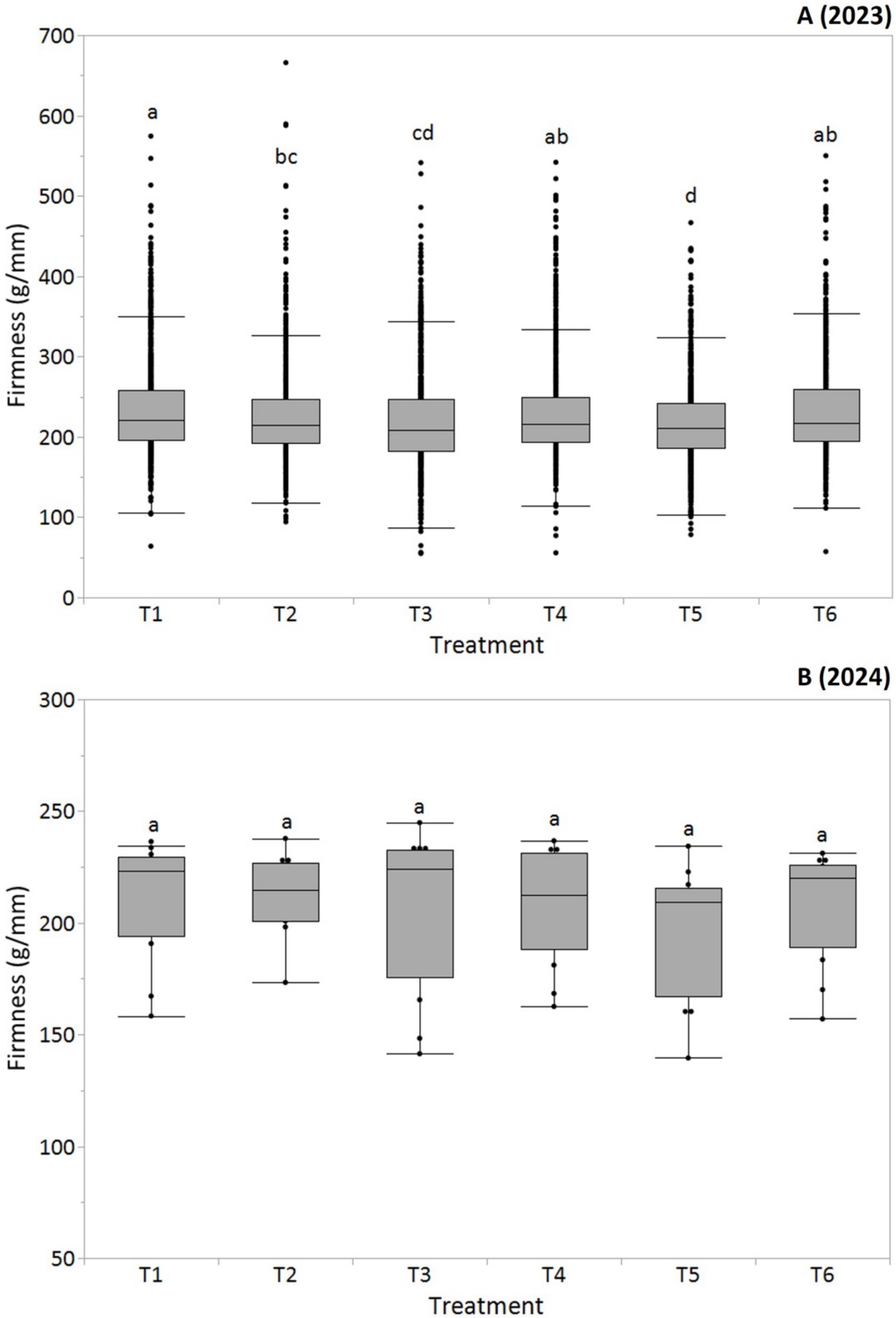

Figure 7. Effect of pruning treatments on berry firmness (g/mm) in 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Effect of pruning treatments on berry firmness (g/mm) in 2023. (B) Effect of pruning treatments on berry firmness (g/mm) in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

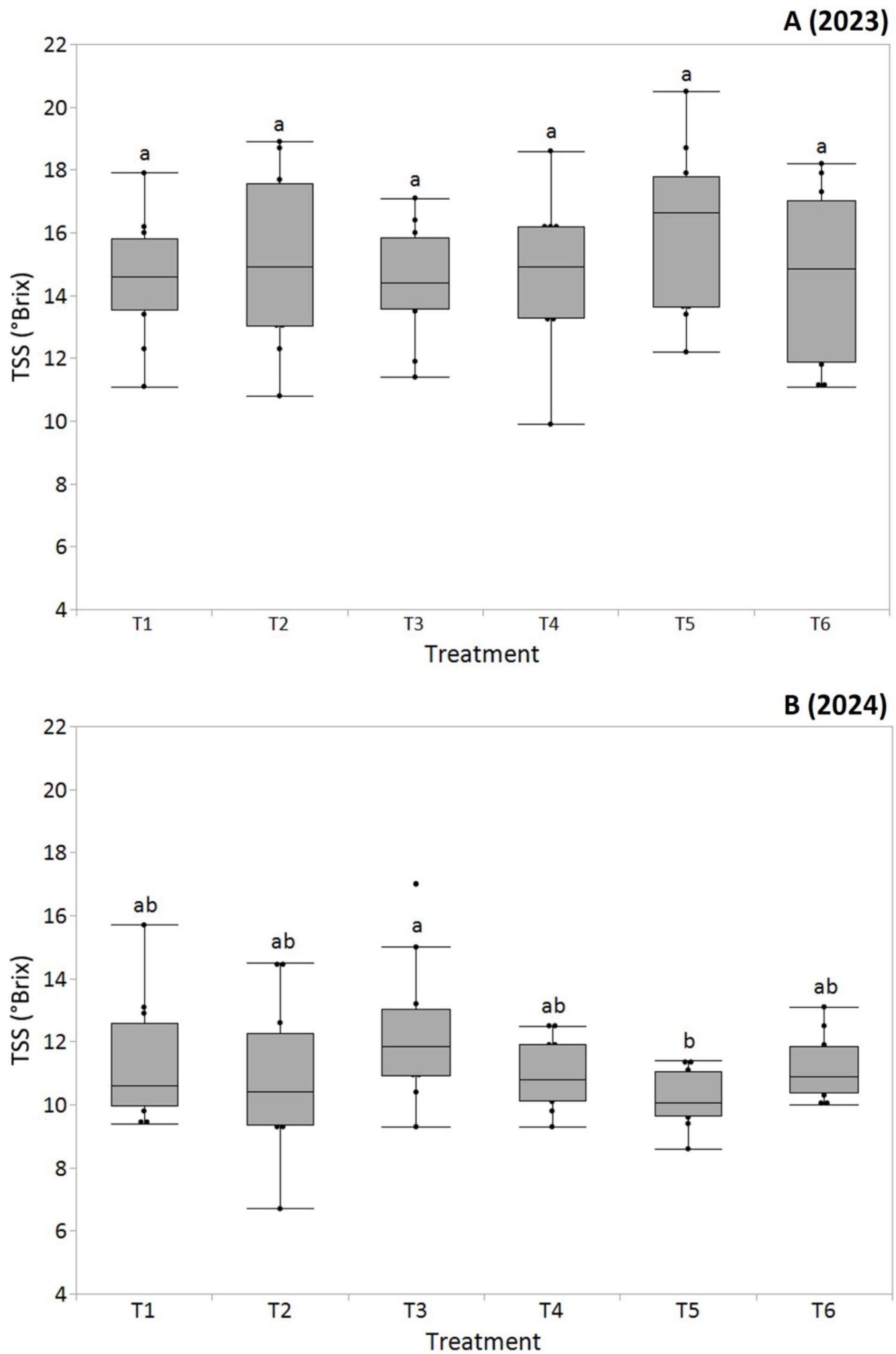

Figure 8. Effect of pruning treatments on the average Total Soluble Solids (TSS [°Brix]) in 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Effect of pruning treatments on the average TSS in 2023. (B) Effect of pruning treatments on the average TSS in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

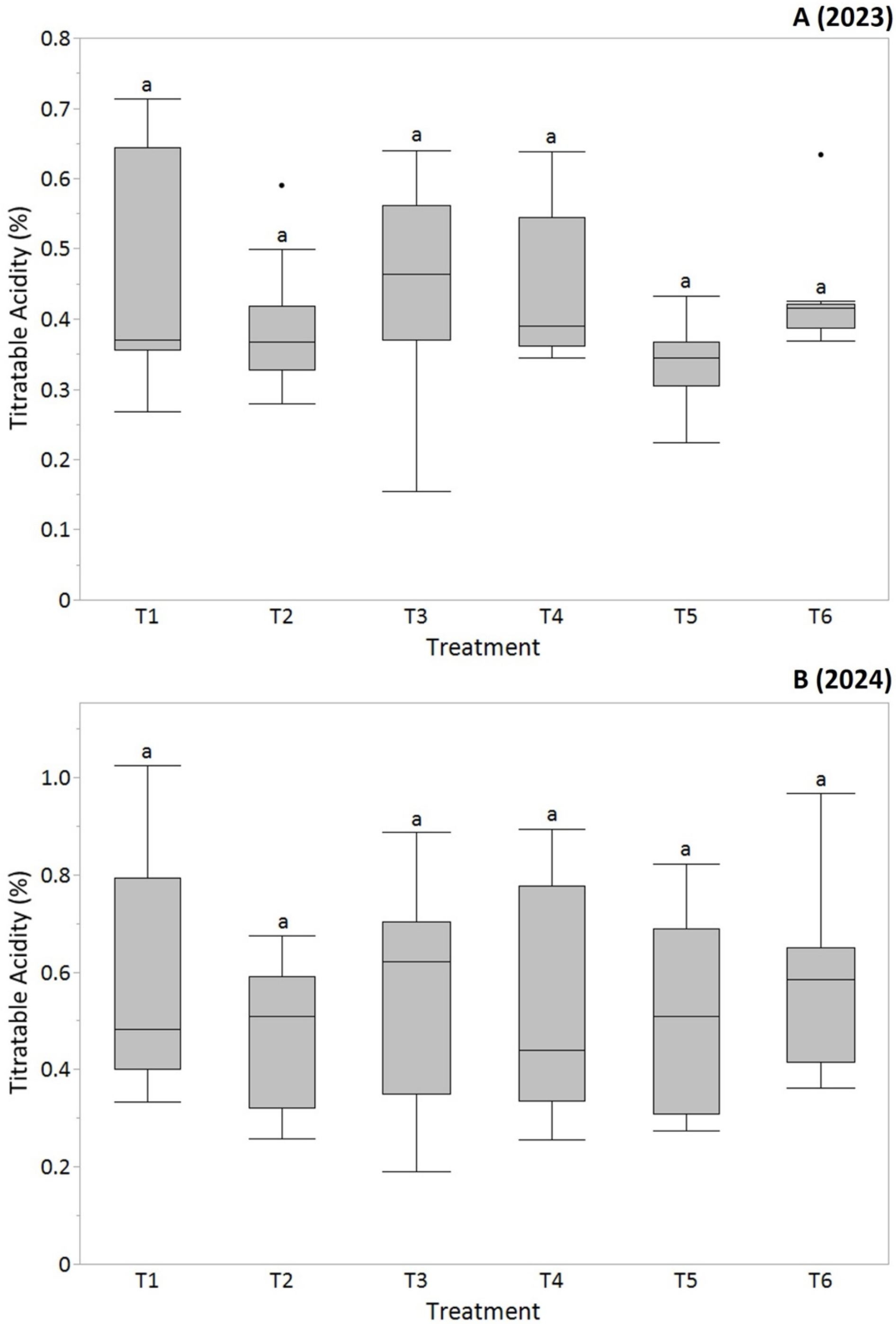

Figure 9. Effect of pruning treatments on the average titratable acidity (TA - %) in 'Farthing', over two growing seasons in Alma, Georgia, USA. The pruning treatments are as follows: T1: 'hedge summer/hand pruned fall', T2: 'hedge summer/tipping in fall' (commercial practice), T3: 'hand pruned fall', T4: 'hand pruned summer/hand pruned fall', T5: 'no pruning or hedging', T6: 'hedge and hand pruned summer/hand pruned fall'. (A) Effect of pruning treatments on the average TA in 2023. (B) Effect of pruning treatments on the average TA in 2024. Different lowercase letters indicate statistically significant differences between treatments ($p<0.05$, Tukey-Kramer all pairs).

There were no significant differences in total soluble solids (TSS; Figure 8) among berries harvested in 2023 from each of the pruning treatments. The lack of differences may be attributed to environmental factors and plant physiological responses during the growing season, particularly during the fruit ripening stage (Jiang et al. 2019). In addition, sufficient leaf area in both pruned and unpruned shoots may have been maintained, which allowed for adequate photosynthetic activity across treatments (Karimi et al. 2019; Strik and Davis 2022). In the 2024 harvest season, berries harvested from T3 (hand pruned in the fall) had the highest TSS compared to the commercial treatment (T2) and no pruned or hedged treatment (T5). Selective pruning might have contributed to better fruit-to-vegetative growth ratios (Hirzel et al. 2023; Retamales and Hancock 2018), leading to greater carbohydrate accumulation in the fruit, which directly contributes to higher TSS levels (Hirzel et al. 2023; Karimi et al. 2017; Kovaleski et al. 2015).

Pruning did not significantly affect titratable acidity (TA) across the different treatments (Figure 9). Similar results have been reported for the rabbiteye blueberry 'Tifblue' and the SHB cultivar 'Misty' (Karimi et al., 2017; Lee et al., 2015).

Pruning duration and labor implications

Growers typically perform summer hedging between mid-June and early July, while tipping occurs in August. Although hedging can be done earlier, we intentionally delayed summer pruning to examine its effect on flower bud formation. Future studies will not only compare different pruning methods (hedging vs. hand pruning) but also evaluate the impact of pruning timing throughout the season.

It is important to mention that in 2022-2023, hand pruning was performed on 4-year-old plants with dense canopies that had never undergone hand pruning before. Summer pruning was performed manually two months after harvest, requiring an average of 5.8 minutes per plant, while fall pruning ranged from 1.8 to 3.6 minutes per plant (data not shown). The longest pruning time in the fall was recorded for plants in T3 (hand pruned fall). In 2023-2024, summer hand pruning averaged 4.8 minutes per plant, while fall pruning times ranged from 1.3 to 3.6 minutes (data not shown). Again, the longest pruning time in the fall was recorded for plants in T3 (hand pruned fall).

The data suggest that summer pruning time decreased slightly in the second year, possibly due to reduced canopy density after the initial pruning. Similarly, fall pruning times for treatments including both summer and fall pruning (T4 and T6) were lower in the second year, indicating that pruning in summer and fall may improve pruning efficiency. However, treatments relying solely on fall pruning (T3) did not exhibit a decrease in pruning duration over time, suggesting that canopy regrowth may offset any potential time savings in the absence of summer pruning. While hand pruning has been shown to enhance fruit quality and yield, it also represents a significant labor cost. However, it is important to note that the pruning personnel involved in this study were less specialized workers than those typically employed for such tasks. Thus, future research should investigate the long-term effects of various pruning techniques on both pruning and harvest efficiency, as well as their impact on overall plant health and productivity and the cost-effectiveness of selective hand pruning for blueberry growers.

Conclusion

Our study demonstrates that selective fall pruning increased blueberry size and weight while improving fruit quality, without negatively impacting total yield. Pruning, particularly hand pruning in the fall, optimizes light distribution within the canopy, leading to concentrated fruit ripening, that may also help reduce harvest costs by minimizing the number of picks. However, selective hand pruning is labor-intensive, and future studies should address cost-effectiveness and labor efficiency to maximize the benefits for Southeastern blueberry producers. As the market increasingly demands "jumbo" berries with extended shelf life and high quality, tailored pruning practices can be an essential tool for growers to stay competitive in a challenging blueberry market.

Literature Cited

Arrington M, DeVetter LW. 2017. Foliar applications of calcium and boron do not increase fruit set or yield in Northern highbush blueberry (*Vaccinium corymbosum*). HortScience. 52(9):1259-1264. https://doi.org/10.21273/hortsci12207-17.

Austin ME. 1997. Winter vs. summer half-hedging of 'Tifblue' rabbiteye blueberry plants. J Small Fruit Vitic. 5(2):39-46. https://doi.org/10.1300/J065v05n02_04.

Brazelton C, Fain C, Ogg M, Riquelme C, Rodriguez V, Ilyas S. 2023. Global State of the Blueberry Industry Report−2023. I.B.O. [Accessed 5 November 2024]. https://www.internationalblueberry.org/2023-report/.

Brazelton C, Fain C, Ogg M, Riquelme C, Rodriguez V, Mulvey D. 2022. Global State of the Blueberry Industry Report−2022. I.B.O. [Accessed 5 November 2024]. https://www.internationalblueberry.org/2022-report/.

Brazelton C, Fain C, Ogg M, Riquelme C, Rodriguez V, Ilyas S. 2024. Global State of the Blueberry Industry Report−2024. I.B.O. [Accessed 5 November 2024]. https://www.internationalblueberry.org/2024-report/.

Cline WO, Brannen PM, Sherm H. 2006. Blueberry Disease management in the Southeastern United States. Acta Hortic. 715:489-492. https://doi.org/10.17660/ActaHortic.2006.715.74.

College of Agricultural & Environmental Science, University of Georgia. 2024. UGA Weather Network. [Accessed 11 December 2024]. http://weather.uga.edu/.

Godoy CA, Monterubbianesi G, Sanchez E, Tognetti JA. 2018. Cluster illumination differentially affects growth of fruits along their ontogeny in highbush blueberry (*Vaccinium corymbosum* L.). Sci Hort. 230:1-10. https://doi.org/10.1016/j.scienta.2017.11.008.

Haralson JC, Brannen PM, Sanders W, Scherm H. 2023. Changes in production practices used for disease management in blueberry nurseries in Georgia, USA, over a 15-year period. HortTechnology. 33(3):268-277. https://doi.org/10.21273/horttech05154-22.

Hirzel J, Retamal-Salgado J, Balbontín C, Muñoz-Vega P, Moya-Elizondo E. 2023. Effect of load regulation by winter pruning on fruit quality attributes of Duke and Legacy blueberry cultivars. Chilean J Agric Res. 83(4):418-431. http://dx.doi.org/10.4067/S0718-58392023000400418.

Jansen WAGM. 1997. Pruning of highbush blueberries. Acta Hortic. 446: 333–336. https://doi.org/10.17660/ActaHortic.1997.446.49.

Jiang Y, Zeng Q, Wei J, Jiang J, Li Y, Chen J, Yu H. 2019. Growth, fruit yield, photosynthetic characteristics, and leaf microelement concentration of two blueberry cultivars under different long-term soil pH treatments. Agron. 9(7):357. https://doi.org/10.3390/agronomy9070357.

Kang DI, Shin MH, Lee SG, Kim HL, Kim JG. 2018. Influence of winter and summer pruning on bush growth, yield and fruit qualities in the southern highbush blueberry ‘Misty’. Hortic Sci Technol. 36(6):799–809. https://doi.org/10.12972/kjhst.20180078.

Karimi F, Baba T, Noma S, Mizuta D, Gook Kim J, Watanabe M, Ishimaru M, Ban T. 2019. Summer pruning severity affected vegetative and reproductive traits in the rabbiteye blueberry (*Vaccinium virgatum* Ait.). Hortic J. 88(3):315-319. https://doi.org/10.2503/hortj.OKD-129.

Karimi F, Igata M, Baba T, Noma S, Mizuta D, Gook Kim J, Ban T. 2017. Summer pruning differentiates vegetative buds to flower buds in the rabbiteye blueberry (*Vaccinium virgatum* Ait.). Hortic J. 86(3):300-304. https://doi.org/10.2503/hortj.MI-158.

Kovaleski AP, Williamson JG, Casamali B, Darnell RL. 2015. Effects of timing and intensity of summer pruning on vegetative traits of two southern highbush blueberry cultivars. HortScience. 50(1):68-73. https://doi.org/10.21273/hortsci.50.1.68.

Krewer G, Stanaland D, Nesmith S, Mullinix B. 2004. Post-harvest hedging and pruning of three year pruning trial on ‘Climax’ and ‘Tifblue’ rabbiteye blueberry. Small Fruits Rev. 3(1-2):203-212. https://doi.org/10.1300/J301v03n01_20.

Kumarihami HPC, Park H-G, Kim S-M, Park J-I, Lee E-J, Kim HL, Kim JG. 2021. Flower and leaf bud density manipulation affects fruit set, leaf-to-fruit ratio, and yield in southern highbush ‘Misty’ blueberry. Sci Hortic. 290:110530. https://doi.org/10.1016/j.scienta.2021.110530.

Lee SG, Cho JG, Shin MH, Oh SB, Kim HL, Kim JG. 2015. Effects of summer pruning combined with winter pruning on bush growth, yields, and fruit quality of ‘Misty’ southern highbush blueberry for two years after planting. Hortic Environ Biotechnol. 56(6):740-748. https://doi.org/10.1007/s13580-015-0101-6.

Michigan State University. 2024. MSU Extension. Blueberries, Growth Stages. [Accessed 11 December 2024]. https://www.canr.msu.edu/blueberries/growing_blueberries/growth-stages.

NASS-USDA. 2023. Noncitrus fruits and nuts 2022 summary. [Accessed 05 November 2024]. https://downloads.usda.library.cornell.edu/usda-esmis/files/zs25x846c/zk51wx21m/k356bk214/ncit0523.pdf.

NASS-USDA. 2024. Noncitrus fruits and nuts 2023 summary. [Accessed 05 November 2024]. https://downloads.usda.library.cornell.edu/usda-esmis/files/zs25x846c/6682zt197/qf85q241d/ncit0524.pdf.

Ojiambo PS, Scherm H, Brannen PM. 2007. Temporal dynamics of septoria leaf spot of blueberry and its relationship to defoliation and yield. Plant Health Prog. 8(1):68. https://doi.org/10.1094/php-2007-0726-05-rs.

Prusa TJ. 2020. An economic analysis of the competitive dynamics in the U.S. fresh blueberry market. Department of Economics, Rutgers University. [Accessed 11 December 2024]. https://www.blueberrycoalitionforprogressandhealth.com/wp-content/uploads/2021/01/An-Economic-Analysis-of-Fresh-Blueberry-Pricing-2020_Prusa.pdf.

Retamales JB, Hancock JF. 2018. Blueberries (2nd ed, Vol. 27). CABI, Wallingford, Oxfordshire, UK. https://www.cabidigitallibrary.org/doi/book/10.1079/9781780647265.0000.

Scherm H, Krewer G. 2003. Blueberry production in Georgia. Small Fruits Rev. 2(4):83-91. https://doi.org/10.1300/J301v02n04_09.

Scherm H, Savelle AT, Brannen PM, Krewer G. 2008. Occurrence and prevalence of foliar diseases on blueberry in Georgia. Plant Health Prog. 9(1):18. https://doi.org/10.1094/php-2008-0421-01-rs.

Schöneberg T, Arsenault-Benoit A, Taylor CM, Butler BR, Dalton DT, Walton VM, Petran A, Rogers MA, Diepenbrock LM, Burrack HJ et al. 2020. Pruning of small fruit crops can affect habitat suitability for *Drosophila suzukii*. Agric Ecosyst Environ. 294:106860. https://doi.org/10.1016/j.agee.2020.106860.

Smith ED. 2019. Cold hardiness and options for the freeze protection of Southern highbush blueberry. Agric. 9(1):9. https://doi.org/10.3390/agriculture9010009

Strik B, Buller G, Hellman E. 2003. Pruning severity affects yield, berry weight, and hand harvest efficiency of highbush blueberry. HortScience. 38(2):196-199. https://doi.org/10.21273/HORTSCI.38.2.196.

Strik BC, Davis AJ. 2022. Pruning method and trellising impact hand- and machine-harvested yield and costs of production in 'Legacy' highbush blueberry. HortScience. 57(7):811-817. https://doi.org/10.21273/hortsci16640-22.

Strik BC, Davis AJ, Jones PA, Finn CE. 2022. Reduced-input pruning methods are a viable option for machine-harvested 'Mini Blues' highbush blueberry. HortScience. 57(10):1313-1320. https://doi.org/10.21273/hortsci16703-22.

Strik BC, Vance A, Bryla DR, Sullivan DM. 2019. Organic production systems in northern highbush blueberry: II. Impact of planting method, cultivar, fertilizer, and mulch on leaf and soil nutrient concentrations and relationships with yield from planting through maturity. HortScience 54(10):1777-1794. https://doi.org/10.21273/hortsci14197-19.