

Standardizing summer pruning techniques for sustainable peach cultivation in subtropical regions

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Abstract

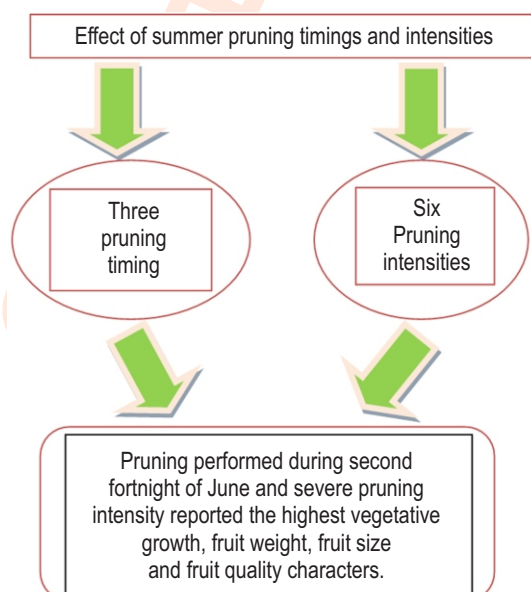
Aim: To study the effects of summer pruning timings, intensities and their interactions on the growth, flowering, yield, and fruit quality of low-chill peach cultivar 'Early Grande'.

Methodology: The present investigations were conducted in 2019 and 2020 on 4-year-old peach trees, involved pruning at three intervals: during the second fortnight of June; first fortnight of July and the second fortnight of July. Six treatments, including five pruning intensities and a control, were applied.

Results: Severe pruning intensity (60% Heading Back + 20% Thinning Out) executed during the second fortnight of June significantly enhanced the vegetative growth, fruit production and better fruit quality in peach cultivar Early Grande.

Interpretation: Timing and intensity of pruning are key factors influencing both tree growth and fruit quality. Although severe pruning reduced yields, it produced fruits of superior quality with potentially higher market value.

Key words: Early Grande cultivar, Heading back, Peach, Summer pruning, Thinning out



Introduction

Peach (*Prunus persica* L. Batsch) is a significant temperate fruit tree with great economic importance worldwide. It is the third most important temperate fruit after apple and pear. This reflects its widespread cultivation and popularity among consumers. China, Spain, Italy and Greece are the top chief producers of peach. In the Indian subcontinent, peach cultivation is primarily concentrated in regions such as Jammu and Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Nilgiri hills, Jharkhand and the North Eastern States (Chaurasiya and Mishra, 2017). These regions provide favorable climatic conditions required for peach trees to thrive. India occupies 17,000 ha area and 1,11,000 MT of production. These numbers highlight the importance of peach industry in the country and its potential for further growth and development. In Himachal Pradesh, peach cultivation has become a significant industry. The peach orchards in Himachal Pradesh cover 4,812 ha of land and yield 2,897 MT of peaches annually. This translates to a remarkable productivity rate of 0.60 MT per hectare, highlighting the success of peach farming in this region.

In subtropical regions, peaches are harvested from April to May. There is a long interval between harvest and flowering for the next season, which can result in excessive vegetative growth and poor development of fruiting shoots. To address this problem, summer pruning plays a crucial role. Summer pruning is a traditional orchard practice that reduces vigorous growth, increases light penetration and ultimately leads to improved yield, quality and income (Rehman *et al.*, 2024). This practice reduces insect pest attacks, balances fruiting and vegetative growth and strengthens fruiting spur shoots. It has been demonstrated to be an effective method for controlling tree growth (Ikinci, 2014). Summer pruning can serve as an effective cultural practice to reduce water demand during postharvest periods, helping conserve irrigation without added costs an advantage under climate change conditions (Conesa *et al.*, 2019).

The impact of summer pruning depends on timing and intensities of pruning, which can affect various aspects of tree growth, such as shoot regrowth, reserve accumulation, fruit yield, flower bud formation, return bloom and fruit quality. Summer pruning performed a month after harvest can influence spring growth by reducing the vigor of new shoots, thereby decreasing competition for water and nutrients (Goke *et al.*, 2020). In recent study, an early summer pruning timing demonstrated the best results in terms of vegetative growth, reproductive traits and quality characteristics in peach (Sharma *et al.*, 2024). Severe pruning intensity induced higher vegetative growth and improved fruit quality in peach (Sharma and Banyal, 2020). Keeping in view of the above, this study was conducted to investigate how different timings and intensities of summer pruning can influence the growth, flowering, fruit set, yield and quality of low-chill peach cultivars.

Materials and Methods

Study area: The experimental peach orchard is located at Neri, Hamirpur, Himachal Pradesh, India, at 31°41'49.98" N latitude and 72°28'02.21" E longitude, 637 m above mean sea level. During the 2019-2020 growing season, the experiment was carried out at the experimental orchard of College of Horticulture and Forestry Neri, Hamirpur, Himachal Pradesh, India. The average mean minimum temperature ranged between 9.5-27.2°C and the maximum temperature ranged between 20.4-41.8°C.

Experimental material and setup: The experiment was conducted on four-year-old peach trees of cv. Early Grande. The trees were planted at 2 x 2 m² intervals. Trees of uniform vigor and size were selected, marked and maintained under similar cultural operations as per recommended Package of Practices for fruit crops by the Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, India.

Six different pruning levels were employed for the study: T₁- 20% Heading Back + 20% Thinning Out, T₂- 30% Heading Back + 20% Thinning Out, T₃- 40% Heading Back + 20% Thinning Out, T₄- 50% Heading Back + 20% Thinning Out, T₅- 60% Heading Back + 20% Thinning Out and T₆- control no heading back. Three distinct pruning timings applied were: D₁-second fortnight of June; D₂- first fortnight of July and D₃- second fortnight of July and interaction between pruning timing and pruning treatment (D×T) were studied. Each treatment was replicated three times, following a factorial Randomized Block Design.

Methods used: To evaluate the impact of pruning treatments, various parameters like vegetative growth, flowering, fruit yield and fruit quality were measured. The annual shoot growth was measured using a measuring tape and the trunk and shoot diameter were assessed using a Vernier Caliper. All pruning treatments were evaluated for yield and the average yield per plant was calculated. The average fruit weight was determined using an electronic top-loading balance and the fruit size, in terms of length and breadth, were measured using Vernier Calipers. Total soluble solids (TSS) were measured using a hand refractometer. The acidity and ascorbic acid content were analyzed according to the methods outlined by Ranganna (1995). Fruit firmness was assessed using a penetrometer.

Statistical analyses: The experimental data collected were suitably computed, tabulated and analyzed using MS-Excel and OPSTAT. The data values were subjected to variance analysis using the Randomized Block Design approach described by Gomez and Gomez (1984).

Results and Discussion

The present investigation focused on the effect of summer pruning timings, intensities and their interaction on the vegetative and quality characters of peach. Data analysis showed that the time of summer pruning had a significant effect on the

annual shoot growth. The highest annual shoot growth (31.61 cm) was recorded in D₁, while the lowest annual shoot growth (27.88 cm) was observed in D₃. Among pruning intensities, the treatment T₅ reported the highest annual shoot length (35.36 cm), while control treatment recorded lowest annual shoot length (24.59 cm) (Table 1). Interaction between the treatments and timings of pruning was statistically significant. The interaction D₁T₅ resulted in the highest shoot length (36.58 cm), however, the lowest shoot length (22.02 cm) was observed in the interaction D₂T₆ (Table 1). The highest percent increase in the shoot diameter (19.13%) and trunk diameter (13.24%) was observed in the plants pruned during second fortnight of June (D₁) whereas the lowest percent increase in the shoot diameter (18.46%) and trunk diameter (12.27%) noted in plants pruned during second fortnight of July (D₃). The treatment T₅ resulted in the highest percent increase in shoot diameter (24.07%) and trunk diameter (17.03%). Whereas, control plants showed the lowest percent increase in the shoot diameter (15.27%) and trunk diameter (8.82%) (Table 1).

The interaction between pruning timings and treatments applied were found to be statistically non-significant. The significant increase in the plant growth observed in early pruned plants may be attributed to reduced competition for photosynthates due to less vegetative growth of the plant, an extended growing period and reduced depletion of available nutrients. Early summer pruning maintains the balance between source and sink relationships, preserving extra carbohydrates for the next season harvest. In contrast, late pruning depletes these carbohydrate reserves, which can lower the tree potential (Pawar and Rana, 2019). These results align with those recorded by Lodolini *et al.* (2019) in olives and Sharma *et al.* (2024) in peaches; they found that trees pruned in early summer exhibited greater vegetative growth.

Additionally, the most severe pruning led to the highest growth, probably because it had removed the extra-vegetative growth, allowing equal distribution of nutrients to the remaining parts of the plant. This improved nutrient flow also resulted in the larger shoot diameters, as nutrients were directed towards the shoots closer to the main branches of the trees. Similar results were reported by Dalkilic *et al.* (2014) in peach; Ikinci *et al.* (2014) in peach; Ghatul *et al.* (2019) in pomegranate and Pandey *et al.* (2025) in guava. The timings of summer pruning did not produce statistically significant effects on the leaf area. T₅ treatment showed maximum leaf surface area (49.02 cm²), while the control trees exhibited the lowest leaf surface area (37.55 cm²) (Table 1). Interaction between pruning timings and treatments were found to be non-significant. Increased pruning intensity, decreases competition for resources, such as photosynthates and other metabolites, leading increased leaf area. Similar findings were also reported by Thakur and Rana (2014) in nectarine and Sharma and Banyal (2020) in peach. The pruning timing D₁ and treatment T₅ resulted in an early emergence of flowering during the year 2020. Specifically, 25% of the flowers emerged on February 1st, 50% on February 3rd and 75% on February 5th. In

contrast, the control treatment delayed flowering emergence, with 25% appeared on February 12th, 50% on February 14th and 75% on February 20th (Fig. 1).

The timings of summer pruning did not produce significant effect on the duration of flowering and days from full bloom to harvest. Pruning performed during the second fortnight of June (D₁) resulted in the highest fruit set (81.90%) and fruit yield (5.09 kg/tree), whereas pruning performed during second-fortnight of July (D₃) recorded the lowest fruit set (80.67%) and fruit yield (4.53 kg/tree) (Table 2). Different pruning intensities significantly influenced the reproductive growth. Severe pruning intensity (T₃) reduced the duration of flowering (6.07 days), fruit set (76.03%), days from full bloom to harvest (75.56 days) and fruit yield (3.27 kg/tree). The longest duration of flowering (8.81 days) and days from full bloom to harvest (84.60 days) were observed in T₆ (Table 2). Treatment T₁ recorded the highest fruit set (85.12%) and fruit yield (6.11 kg/tree). Interaction between pruning timings and treatments significantly affected fruit yield. The treatment combination D₁T₁ resulted in the highest yield (6.35 kg/tree), while treatment combination D₃T₅ recorded the lowest yield (3.01 kg/tree) (Table 2). Early summer pruning resulted in higher fruit set and yield due to improved physiological condition, increased flowering and enhanced nutrient availability (Hussein, 2012). These findings are consistent with the results reported by Jafarlou *et al.* (2016) and Sharma *et al.* (2024) in peach. Severe summer pruning enhances light interception within the canopy. Summer pruning not only increases light penetration but also alters the hormonal balance among the meristems, which promotes the development of flower buds (Bhusal *et al.*, 2017). This improved development of fruit buds may contribute to early flowering which results in shorter flowering duration. Similarly, Singh *et al.* (2012) noted that the severity and timing of pruning significantly influences vegetative growth, tree canopy shape and stimulates bud sprouting, ultimately leading to early flowering and fruiting.

The duration of bud sprouting has decreased with higher pruning levels, which may be attributed to a lower number of available buds on the shoot. Additionally, the reserve metabolites from the trunk could have contributed to the early sprouting of these buds (Chander *et al.*, 2022). The fruit set and fruit yield were highest in lightly pruned trees and decreased with increasing severity of pruning. This decrease in fruit set and fruit yield with increasing pruning severity may be attributed to lesser number of fruiting spurs retained on the severely pruned shoots and increased vegetative growth, which could potentially lead to the formation of a reduced number of fruiting spurs. Reduced fruiting areas on severely pruned trees decreased both fruit set and yield in nectarine (Thakur and Rana, 2014). Similar results were reported by Lesicar *et al.* (2017) and Sharma and Banyal (2020) in peach; Miaotai *et al.* (2021) and Rehman *et al.* (2024) in apple. Their findings demonstrated that severe pruned plants recorded the lowest fruit yield, while light pruned or control plants recorded the highest yield. T₅ treatment and summer pruning timing D₁ recorded the highest percentage of super-large fruits (18.5%), super-medium fruits (56.5%) and lowest percentage of super-

Table 1: Effect of summer pruning timings and pruning intensities and their interactions on annual shoot growth (cm), shoot diameter, trunk diameter and leaf area in peach cv. Early Grande

Treatments	Annual shoot growth (cm)				Shoot diameter (%)				Trunk diameter (%)				Leaf area (cm ²)			
	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean
T ₁ : 20% HB + 20% TO	28.16	27.20	25.29	26.88	15.87	15.83	15.36	15.68	10.53	10.18	9.19	9.96	41.54	41.34	38.46	40.45
T ₂ : 30% HB + 20% TO	31.53	28.96	26.83	29.11	17.05	17.01	16.99	17.02	12.37	11.66	11.47	11.83	45.00	43.75	39.64	42.79
T ₃ : 40% HB + 20% TO	33.20	31.62	28.79	31.20	19.33	19.30	19.12	19.25	14.27	13.98	12.60	13.61	46.52	44.62	43.01	44.72
T ₄ : 50% HB + 20% TO	34.89	34.20	30.70	33.26	22.25	21.26	20.81	21.44	16.04	15.67	15.09	15.61	47.52	47.49	45.34	46.78
T ₅ : 60% HB + 20% TO	36.58	35.84	33.66	35.36	24.49	24.09	23.63	24.07	17.13	17.09	16.87	17.03	50.30	49.46	47.30	49.02
T ₆ : Control	25.25	26.51	22.02	24.59	15.81	15.19	14.83	15.27	9.12	8.95	8.39	8.82	38.29	36.91	37.46	37.55
Mean	31.61	30.72	27.88		19.13	18.78	18.46		13.24	12.92	12.27		44.86	43.93	41.86	
CD_{0.5}																
Treatment (T)	0.81			0.57				0.08				6.15				
Time (D)	0.57			0.40				0.06				NS				
Treatment X Time (TXD)	1.41			NS				NS				NS				

* HB- Heading Back, TO- Thinning Out; * Values in the parentheses are square root transformed

Table 2: Effect of summer pruning timings and pruning intensities and their interactions on duration of flowering, fruit set, days from full bloom to harvest and fruit yield in peach cv. Early Grande

Treatments	Duration of flowering (days)				Fruit set (%)				Days from full bloom to harvest				Fruit yield (kg/tree)			
	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean
T ₁ : 20% HB + 20% TO	8.00	8.22	8.33	8.18	86.23	84.63	84.49	85.12	83.00	83.33	84.07	83.46	6.35	6.26	5.73	6.11
T ₂ : 30% HB + 20% TO	7.58	7.90	7.95	7.81	84.10	83.57	82.83	83.50	80.07	81.33	81.67	81.02	5.47	5.38	5.37	5.41
T ₃ : 40% HB + 20% TO	7.10	7.40	7.46	7.32	80.46	80.00	79.60	80.02	78.66	79.00	79.33	79.00	4.84	4.61	4.03	4.49
T ₄ : 50% HB + 20% TO	6.40	6.66	7.26	6.77	78.66	77.96	77.93	78.19	76.67	77.33	77.66	77.22	4.18	3.87	3.37	3.81
T ₅ : 60% HB + 20% TO	6.00	6.05	6.18	6.07	76.48	75.99	75.62	76.03	75.00	75.67	76.00	75.56	3.73	3.07	3.01	3.27
T ₆ : Control	8.73	8.85	9.05	8.81	85.46	83.93	83.54	84.31	84.00	84.67	85.13	84.60	5.99	5.71	5.67	5.78
Mean	7.30	7.51	7.71		81.90	81.01	80.67		79.56	80.22	80.64		5.09	4.82	4.53	
CD_{0.5}																
Treatment (T)	1.46			0.59				2.34				0.16				
Time (D)	NS			0.41				NS				0.12				
Treatment X Time (TXD)	NS			NS				NS				0.29				

*HB- Heading Back; TO- Thinning Out

small fruits (25%), while the lowest percentage of super-large (2.7%), super-medium (25.2%) fruits and highest percentage of super-small fruits (72.1%) was recorded in control treatment (Fig. 2). Fewer flower buds on severely pruned trees were

compensated by larger fruit size. The reduced fruit quantity on the trees enhances the availability of nutrients for each individual fruit, thereby promoting increased fruit size and consequently leading to a higher proportion of super-sized grade fruits (Thakur

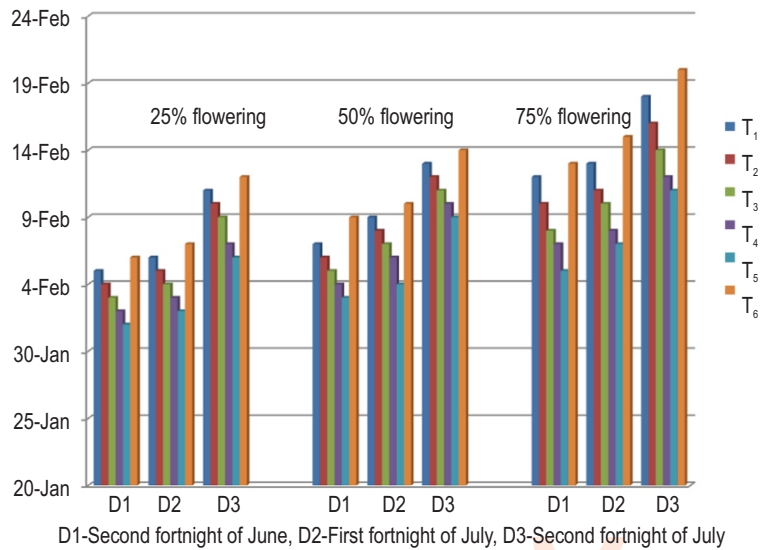


Fig.1: Effect of summer pruning timing and intensities on flowering.

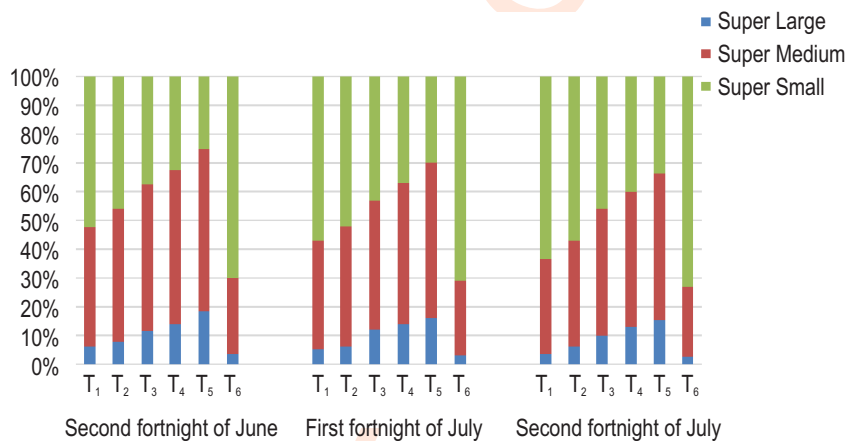


Fig. 2: Effect of summer pruning timing and intensities on fruit grading.

and Rana, 2014). Rehman *et al.* (2024) also recorded the highest A-grade fruits with moderate to severe pruning intensity in apple. The highest fruit weight (94.37 g), fruit length (5.29 cm) and fruit breadth (5.62 cm) were observed in the plants that were pruned during second fortnight of June (D₁), while the plants pruned during second fortnight of July (D₃) showed the lowest fruit weight (92.01 g), fruit length (5.15 cm) and fruit breadth (5.39 cm). Among different pruning treatments, T₅ reported the highest fruit weight (103.55 g), fruit length (5.64 cm) and fruit breadth (6.02 cm), however, treatment T₆ reported the lowest fruit weight (83.71 g), fruit length (4.80 cm) and fruit breadth (5.04 cm) as depicted in Fig. 3. The interaction between timings and treatments (D x T) was statistically non-significant (Table 3). The maximum fruit weight and size were observed in fruit plants pruned during 2nd week of June, which could be due to the stimulation of optimal

vegetative growth, which helps maintain a balance between the leaf and fruit, resulting in optimal fruit weight and size (Singh *et al.*, 2012). Similarly, Sharma *et al.* (2024) reported that summer pruning executed in early season resulted in highest fruit weight and fruit size. Increasing pruning severity reduces fruit number while increasing leaf-to-fruit ratio, enhancing carbohydrate synthesis for larger fruit size and weight (Mohamed *et al.*, 2014). Similar findings were reported by Singh and Saini (2013) in peach; Sharma and Singh (2018) in pomegranate; Sharma and Banyal (2020) in peach and Pandey *et al.* (2025) in guava.

The timing of summer pruning significantly influenced various fruit quality parameters. Pruning executed during second fortnight of June (D₁), showed the highest total soluble solids content (11.27°B) (Table 3), ascorbic acid content (16.37 mg

Table 3: Effect of summer pruning timings, cultivars, pruning intensities and their interactions on fruit weight, fruit size and total soluble solids in peach cv. Early Grande

Treatments	Fruit weight (g)				Fruit length (cm)				Fruit breadth (cm)				Total soluble solids (°B)			
	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean
T ₁ : 20 % HB + 20% TO	86.53	86.46	86.03	86.34	5.04	4.86	4.83	4.91	5.24	5.24	5.01	5.16	10.30	10.13	9.46	9.96
T ₂ : 30 % HB + 20% TO	88.36	88.35	87.71	88.14	5.23	5.15	5.07	5.15	5.50	5.45	5.39	5.45	10.66	10.50	10.46	10.54
T ₃ : 40 % HB + 20% TO	97.28	94.92	94.09	95.43	5.39	5.38	5.29	5.35	5.73	5.73	5.52	5.66	11.40	11.06	10.93	11.13
T ₄ : 50 % HB + 20% TO	103.16	100.15	100.04	101.12	5.56	5.52	5.46	5.51	5.96	5.94	5.71	5.87	12.16	11.70	11.33	11.73
T ₅ : 60 % HB + 20% TO	105.14	103.06	102.46	103.55	5.69	5.68	5.57	5.64	6.16	6.11	5.77	6.02	13.16	12.01	11.96	12.38
T ₆ : Control	85.77	83.62	81.75	83.71	4.86	4.84	4.70	4.80	5.10	5.10	4.93	5.04	9.93	9.40	9.06	9.46
Mean	94.37	92.76	92.01		5.29	5.24	5.15		5.62	5.59	5.39		11.27	10.80	10.53	
CD_{0.5}																
Treatment (T)	1.50				0.11				0.14				0.49			
Time (D)	1.06				0.08				0.10				0.35			
Treatment X Time (T X D)	NS				NS				NS				NS			

*HB- Heading Back, TO- Thinning Out

Table 4: Effect of summer pruning timings, pruning intensities and their interactions on titratable acidity, fruit firmness and ascorbic acid in peach cv. Early Grande

Treatments	Titratable acidity (%)				Fruit firmness (kg cm ⁻²)				Ascorbic acid (mg 100g ⁻¹)			
	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean	D ₁	D ₂	D ₃	Mean
T ₁ : 20 % HB + 20% TO	0.86	0.92	0.96	0.91	5.80	6.00	6.26	6.02	13.82	13.46	12.48	13.25
T ₂ : 30 % HB + 20% TO	0.78	0.91	0.92	0.87	5.60	5.76	5.83	5.73	16.08	14.28	13.14	14.50
T ₃ : 40 % HB + 20% TO	0.73	0.74	0.83	0.76	5.10	5.46	5.50	5.35	17.43	16.54	15.41	16.46
T ₄ : 50 % HB + 20% TO	0.66	0.68	0.69	0.68	4.90	5.40	5.48	5.26	18.93	16.96	15.64	17.17
T ₅ : 60 % HB + 20% TO	0.57	0.61	0.62	0.61	4.43	4.73	4.80	4.65	19.49	19.27	18.78	19.18
T ₆ : Control	0.97	1.04	1.07	1.03	6.20	6.23	6.66	6.36	12.46	12.01	11.78	12.08
Mean	0.76	0.81	0.84		5.33	5.60	5.75		16.37	15.42	14.54	
CD_{0.5}												
Treatment (T)	0.09				0.42				2.00			
Time (D)	NS				0.29				1.41			
Treatment X Time (T X D)	NS				NS				NS			

*HB- Heading Back, TO- Thinning Out

100g⁻¹) and lowest fruit firmness (5.33 kg cm⁻²) (Table 4). Whereas, plants pruned during second fortnight of July (D₃) showed the lowest total soluble solids (10.53°B) (Table 3), ascorbic acid content (14.54 mg 100g⁻¹) and the highest fruit firmness (5.75 kg cm⁻²) (Table 4). Different pruning intensities also had a significant impact on the fruit quality. The most severe pruning treatment T₅ recorded the highest total soluble solids (12.38°B) (Table 3), ascorbic acid content (19.18 mg 100 g⁻¹) and lowest titratable acidity (0.61%) and fruit firmness (4.65 kg cm⁻²) (Table 4). However, T₆ treatment recorded the lowest TSS (9.46°B) (Table 3) and ascorbic acid content (12.08 mg 100 g⁻¹) and highest titratable acidity (1.03%) and fruit firmness (6.36 kg cm⁻²) (Table 4).

Pruning performed during second fortnight of June (D₁) resulted in the highest quality attributes which might be due to the increased carbohydrate synthesis, enhanced photosynthate translocation, nutrient uptake and deposition in fruit tissues, all contributing to improved fruit quality (Singh *et al.*, 2012). Increase in pruning severity induces reduction in shading, which increases light penetration into the interior parts of the canopy. Higher light interception enhances higher production of carbohydrates and their translocation to the production sites, thereby improving the fruit quality (Mohamed *et al.*, 2014). Similar results were reported by Goncalves *et al.* (2013) in peach; Thakur and Rana (2014) in nectarine; Zayan *et al.* (2015) in peach and Pandey *et al.* (2025) in



Fig. 3: Performance of summer pruning in low chill peaches.

guava. Additionally, fruit firmness decreased as pruning severity increased, possibly due to larger fruit size and reduced cell wall concentration and strength associated with severe pruning was also observed by Pawar and Rana (2019) and Sharma *et al.* (2024) in peach.

This study provides valuable insights into optimizing summer pruning practices for low-chill peach cultivation in subtropical regions, particularly Himachal Pradesh, Ludhiana, parts of UP and J & K. Our findings indicate that a severe pruning intensity-60% heading back and 20% thinning out and early pruning timing second fortnight of June, results in the highest annual shoot length, trunk diameter, leaf area, minimum flowering duration, minimum days to harvest and highest fruit quality characters in peach cultivar Early Grande. In subtropical areas peaches are typically harvested by April-May, leading to a prolonged vegetative phase until the next flowering cycle begins. This extended post-harvest vegetative period provides an ideal opportunity for summer pruning. By strategically managing this period with early and severe pruning, as demonstrated in this study, growers can enhance vegetative vigor, regulate tree architecture, improve flowering and boost fruit quality for the following season's crop. Furthermore, early and severe pruning helps optimize canopy structure, reduces the risk of excessive vegetative growth, and ensures efficient resource distribution for the subsequent reproductive phase. Thus, adopting this pruning strategy can serve as a valuable orchard management tool in

similar agro-climatic zones, helping peach growers maximize yield potential, maintain tree health and ensure superior fruit quality in regions with a subtropical climate and a low-chill requirement.

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Authors' contribution: A. Thakur: Investigation and data collection; A.K. Banyal: Conceptualization, planning and drafting of manuscript; S.K. Banyal: Technical inputs during execution; T. Guleria: Statistical analysis; N. Thakur: Interpretation of data.

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References

- Bhusal, N., H Su-Gon and Y. Tae-Myung: Summer pruning and reflective film enhance fruit quality in excessively tall spindle apple trees. *Hortic. Environ. Biotechnol.*, **58**, 560-567 (2017)
- Chander, S., R.M. Kurian, J. Satisha, K.K. Upreti and R.H. Laxman: Advancing fruiting season in Annona cv. Arka Sahana through pruning. *J. Horticult. Sci.*, **17**, 316-324 (2022).
- Chaurasiya, P.C. and R.K. Mishra: Varietal performance of peach [*Prunus persica* (L.) Batsch] under northern hill zone of Chhattisgarh. *Int. J. Chemical Stud.*, **5**, 37-40 (2017).
- Conesa M.R., L.M. Lopez, W. Conejero, J. Vera and M.C. Sanchez: Summer pruning of early-maturing *Prunus persica*: water implication. *Sci. Horticult.*, **256**, 1-8 (2019).
- Dalkilic, G.G., Z. Dakilic and H.O. Mestav: Effect of different pruning severity on vegetative growth in peach. *Turkish J. Agricul. Nat. Sci.*, **2**, 1505-1508 (2014).
- Ghatul, I.D., V.S. Jagtap, A.A. Solanke and S.J. Ban: Effect of different levels of pruning on yield of pomegranate (*Punica granatum* L.) cv. Super Bhagwa. *Int. J. Chemi. Stud.*, **7**, 2367-2369 (2019).
- Goke, A., S. Serra and S. Musacchi: Manipulation of fruit dry matter via seasonal pruning and its relationship to d'Anjou pear yield and fruit quality. *Agronomy*, **10**, 897-919 (2020).
- Gomez, K.A. and A.A. Gomez: Statistical Procedure for Agricultural Research. John Wileys & Sons, Inc., New York, USA, 680 pages (1984).
- Goncalves, M.A., C. Cocco, G.K. Vignolo, T. Picolotto and L.E.C. Antunes: The effect of pruning intensity in the production and

- quality of peach fruits. *Braz. J. Fruit Sci.*, **36**, 742-747 (2013).
- Hussein, A.M.: Effect of summer pruning on vegetative growth, yield and fruit quality of Le-conte pear trees. *J. Amer. Sci.*, **8**, 640-647 (2012).
- Ikinci, A., A. Kuden and E.A.K. Bekir: Effect of summer and dormant pruning time on the vegetative growth, yield, fruit quality and carbohydrate content of two peach cultivars. *African J. Biotechnol.*, **13**, 84-90 (2014).
- Ikinci, A.: Influence of pre- and post harvest summer pruning on the growth, yield, fruit quality and carbohydrates content of early season peach cultivars. *Sci. World J.*, **2014**, 1-8 (2014).
- Jafarlou, A.M., M. Poursoltan, B. Deltalab and S. Amiri: The effect of green pruning times on some physiological characteristics of peach Redtop cultivar in Morgan region. *Azarian J. Agricul.*, **3**, 66-69 (2016).
- Lesicar, J., Z. Sindrak, J.S Zlabur, S. Voca and M.S. Babojelic: Influence of fruit thinning and summer pruning on the yield and fruit quality of peach cultivar 'Royal Gem. *Agricul. Conspe. Scientifi.*, **81**, 155-159 (2017).
- Lodolini, E.M., S. Polverigiani, T. Cioccolanti, A. Santinelli and D. Neri: Preliminary results about the influence of pruning time and intensity on vegetative growth and fruit yield of a semi-intensive olive orchard. *J. Agric. Sci. Techno.*, **21**, 969-980 (2019).
- Miaotai, Y., X. Zhao, A. Biswas, G. Huo, B. Yang, Y. Zou, K.H.M. Siddique and X. Gao: Measurements and modeling of hydrological responses to summer pruning in dryland apple orchards. *J. Hydrol.*, **594**, 1-13 (2021).
- Mohamed, M.S., T.A. Fayed, A.M. Hussein and S.M. Maged: Effect of some pruning application on leaf to fruit ratio, yield and fruit quality of 'Florida Prince' peach tree. *J. Horticult. Sci. Orn. Plants*, **6**, 18-26 (2014).
- Pandey, V., A. Kumar, K. Sharma, D. Keshari, A. Kumar and D. Pal: Influence of pruning intensity on growth, yield and bio-chemical parameters of guava (*Psidium guajava* L.) Cv. Shweta under North Indian conditions. *Vegetos*, **22**, 1-8 (2025).
- Pawar, R. and V.S. Rana: Manipulation of source-sink relationship in pertinence to better fruit quality and yield in fruit crops: A review. *Agricult. Revi.*, **40**, 200-207 (2019).
- Ranganna, S.: Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Edn., Tata Mc Graw, Hill Publishing Co. Ltd., New Delhi, pp. 9-10 (1995).
- Rehman, H., M.A. Ganai, T. Mubarak, A.S. Khanday and S.A. Shergojry. Yield and quality performance of apple under varied summer pruning intensities in North-Western Himalyan region. *Int. J. Environ. Agric. Biotech.*, **9**, 336-343 (2024).
- Sharma, D.P. and N. Singh: Effect of rejuvenation pruning on the growth, productivity and disease incidence in declining trees of pomegranate (*Punica granatum* L.) cv. Kandhari Kabuli. *J. Appl. Nat. Sci.*, **10**, 358-362 (2018).
- Sharma, R. and A.K. Banyal: Effect of summer pruning intensities on growth, quality and yield of low chill peach (*Prunus persica* L. Batsch.) cv. Early Grande. *J. Crop Weed*, **16**, 210-215 (2020).
- Sharma, R., A.K. Banyal and S. Sharma: Differential responses of summer pruning timing on growth, quality and yield of low chill peach. *Isr. J. Plant Sci.*, **71**, 25-35 (2024).
- Singh, A., B.C. Deka, R.K. Patel, A. Nath and S.R. Mulieh: Effect of pruning time, severity and tree aspects on harvesting period and fruit quality of low chilling peach (*Prunus persica*). *Indian J. Agric. Sci.*, **82**, 862-866 (2012).
- Singh, G. and S.P. Saini: Effect of pruning and fruit thinning on yield and fruit weight of peach (*Prunus persica* (L) Batsch) cv. Shan-i-Punjab in sub-Mountain zone of Punjab-an on-farm study. *J. Appl. Hortic.*, **15**, 65-68 (2013).
- Thakur, N. and V.S. Rana: Influence of pruning intensity on yield and quality of nectarine peach. *J. Hortic. Sci.*, **9**, 23-26 (2014).
- Zayan, M.A., S.M. Zeerban, G.B. Mikhael and H.M.A. Ogiela: Improving productivity and fruit quality of Florida Prince peach trees by using some agriculture treatments. *Egypt. J. Horticult.*, **42**, 37-57 (2015).