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Effect of Leaf Pruning and Plant Growth Regulators on Growth, Yield and Quality of Summer Squash under Himalayan Valley Conditions

Payal Kumari Kumawat [a], K. N. Shah [a], Sanjay Seemawat [b*], D. K. Rana [a], Manisha Kumawat [c] and Vivek Singh [a]

[a] Department of Horticulture, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar, Uttarakhand, India.
[b] Department of Horticulture, Rajasthan College of Agriculture, MPUAT Udaipur, Rajasthan, India.
[c] Department of Horticulture, Agriculture University Jodhpur, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

Abstract

A field experiment was conducted during summer 2024 at the Horticultural Research Centre, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand, India, to evaluate the individual and interaction effects of leaf pruning and gibberellic acid (GA_3) on summer squash (*Cucurbita pepo* L.) cv. Pusa Pasand. The experiment was arranged in a factorial randomised block design with three replications. Three pruning treatments—no pruning, removal of the first and second leaves at 45 days after sowing (DAS), and removal of the third and fourth leaves at 55 DAS—were combined with four GA_3 concentrations: 0, 100, 200 and 400 ppm, producing 12 treatment combinations. Growth observations were recorded at 45 DAS, 60 DAS and harvest, while yield and fruit-quality attributes were assessed at harvest. The combination P_2G_3, comprising removal

**Corresponding author: E-mail: sanjayraj4116@gmail.com;*

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of the third and fourth leaves at 55 DAS with 400 ppm GA_3, recorded the highest harvest plant height (45.72 cm), plant spread (2,180.97 cm^2), stem base diameter (2.05 cm) and number of leaves per plant (25.86). It also produced 22.50 male flowers, 3.23 female flowers, 3.06 fruits per plant, an average fruit weight of 167.63 g, a plot yield of 39.20 kg and a yield of 156.80 q ha^{-1}. Quality responses varied among treatments: maximum total soluble solids, ascorbic acid content and fruit dry weight occurred under P_1G_2, P_2G_1 and P_1G_0, respectively. Thus, P_2G_3 showed the strongest overall response for growth and yield, whereas quality optimisation was trait-specific.

Keywords: Summer squash; leaf pruning; gibberellic acid; growth; yield; quality.

1. Introduction

Summer squash (*Cucurbita pepo* L.) is a popular cucurbitaceous vegetable cultivated in many countries as a food crop (Abou El-Saad et al., 2020). It is an annual, monoecious vegetable with a chromosome number of 2n = 40. Mexico is considered its centre of origin (Bisognin, 2002). The plant may have a trailing vine or bush growth habit, and bush types have greatly shortened internodes and set fruits in close succession (Thamburaj & Singh, 2001). The flowers occur singly in the leaf axils. Pistillate and staminate flowers are large and conspicuous and can be distinguished by the ovary attached to the female flower (Robinson & Decker-Walters, 1997). Summer squash is harvested at an immature stage, when the skin is soft and edible. It is low in calories and contains antioxidants, including vitamin C and beta-carotene. To increase squash production, improved cultivation technologies may be adopted (Kumar & Kumar, 2020). One such approach is the improvement of cultivation practices through appropriate training and pruning. Summer squash grows rapidly and prolifically; therefore, manipulation of plant architecture through pruning and training may optimise yield and fruit quality. Pruning can improve photosynthetic efficiency and plant performance by reducing competition and enhancing the utilisation of growth factors (Ayala-Tafoya et al., 2019).

Gibberellins are potent growth promoters that lengthen internodes, promote flowering in several plants, and modify sex expression in some species (Davies, 1995). Gibberellic acid is a pentacyclic diterpene acid that promotes growth through cell elongation. Gibberellins stimulate cells in germinating seeds to produce mRNA molecules encoding hydrolytic enzymes. Gibberellic acid is a potent hormone whose natural occurrence in plants regulates development. Because GA_3 regulates growth, applications at very low concentrations can markedly affect plants, whereas excessive concentrations may produce the opposite response (Riley, 1987).

Recent evidence from cucumber production systems indicates that canopy-training strategies can alter leaf-area development, light interception and marketable yield (Samba et al., 2023). However, the response to pruning is context-dependent, as excessive removal of young leaves may reduce leaf area, dry-matter production and cumulative yield (Winkeler et al., 2026).

Recent studies have also shown that GA_3-based foliar treatments can influence vegetative growth, flowering, yield and quality traits in cucumber (Dahal & Dahal, 2022; Jha et al., 2024), while molecular evidence supports the involvement of gibberellin regulatory networks in cucumber fruit set and development (Mandal et al., 2022). Comparable growth, yield and quality responses to foliar plant-growth-regulator treatments have been reported in bitter gourd, another cucurbit (Naga et al., 2025; Shah et al., 2022).

Despite the available evidence, the combined effect of precisely timed leaf pruning and graded GA_3 concentrations on the growth, yield and quality of summer squash under Himalayan valley conditions remains insufficiently documented. The response may vary with pruning stage, hormone concentration and local growing conditions, thereby requiring location-specific evaluation.

The present study was therefore undertaken to evaluate the individual and interaction effects of leaf pruning and foliar GA_3 application on the growth, yield and quality attributes of summer squash cv. Pusa Pasand under Himalayan valley conditions.

2. Materials and Methods

The experiment was conducted at the Horticultural Research Centre, Department of Horticulture, Chauras Campus, Hemvati Nandan Bahuguna Garhwal University, Srinagar (Garhwal), Uttarakhand, India, during summer 2024. Geographically, the Horticultural Research Centre is situated in the Alaknanda Valley at 78°47′30″ E longitude and 30°13′9″ N latitude, in the Garhwal region. The experiment comprised two factors. Leaf pruning had three levels: no pruning (P_0), pruning of the first and second leaves at 45 DAS (P_1), and pruning of the third and fourth leaves at 55 DAS (P_2). GA_3 had four levels: no spray (G_0), 100 ppm (G_1), 200 ppm (G_2) and 400 ppm (G_3). The 12 treatment combinations were P_0G_0 (control), P_0G_1 (no pruning + 100 ppm GA_3), P_0G_2 (no pruning + 200 ppm GA_3), P_0G_3 (no pruning + 400 ppm GA_3), P_1G_0 (pruning of the first and second leaves at 45 DAS + no spray), P_1G_1 (pruning of the first and second leaves at 45 DAS + 100 ppm GA_3), P_1G_2 (pruning of the first and second leaves at 45 DAS + 200 ppm GA_3), P_1G_3 (pruning of the first and second leaves at 45 DAS + 400 ppm GA_3), P_2G_0 (pruning of the third and fourth leaves at 55 DAS + no spray), P_2G_1 (pruning of the third and fourth leaves at 55 DAS + 100 ppm GA_3), P_2G_2 (pruning of the third and fourth leaves at 55 DAS + 200 ppm GA_3), and P_2G_3 (pruning of the third and fourth leaves at 55 DAS + 400 ppm GA_3). The experiment was laid out in a factorial randomised block design with three replications, using the cultivar Pusa Pasand. The experimental field was prepared by three cross-ploughings, followed by harrowing, planking and levelling 15 days before seed sowing. Ridges and furrows were prepared 1 m apart, and basins were prepared at 1 m spacing according to the experimental layout. The first pruning was performed at 45 DAS by removing the first and second leaves manually through twisting at the leaf base. The second pruning was performed at 55 DAS by removing the third and fourth leaves. GA_3 solutions at the specified concentrations were applied as foliar sprays at 45 and 60 DAS and were prepared according to the treatment details. Analysis of variance was performed for the factorial randomised block design at the 5% level of significance. The critical difference at the 5% probability level was calculated to compare treatment means whenever the F-test was significant.

3. Results and Discussion

3.1 Growth Parameters

Data on the effects of leaf pruning, foliar GA_3 application and their interaction on growth parameters are presented in Tables 1 and 2. At 45 DAS, the maximum plant height (29.29 cm; Fig. 1), plant spread (815.33 cm^2; Fig. 2), stem base diameter (1.47 cm) and number of leaves per plant (11.93) were recorded under P_2.

Among the GA_3 concentrations, the greatest plant height at 45 DAS (28.38 cm) was recorded under G_2 (200 ppm), whereas the greatest plant spread (803.66 cm^2) and number of leaves per plant (11.71) were recorded under G_3 (400 ppm). The maximum stem base diameter (1.37 cm; Fig. 3) was recorded under G_0 (no spray).

The interaction between leaf pruning and foliar GA_3 application showed that, at 45 DAS, the maximum plant height (35.80 cm) was recorded under P_0G_2, the maximum plant spread (1,100.78 cm^2) under P_2G_3, the maximum stem base diameter (1.83 cm) under P_2G_0, and the maximum number of leaves per plant (12.93; Fig. 4) under P_2G_3.

At 60 DAS, the maximum plant height (30.60 cm), plant spread (1,321.75 cm^2) and number of leaves per plant (20.44) were recorded under P_2, whereas the maximum stem base diameter (1.42 cm) was recorded under P_1.

Among the GA_3 concentrations at 60 DAS, the maximum plant height (30.83 cm) was recorded under G_1 (100 ppm), whereas the maximum plant spread (1,337.45 cm^2), stem base diameter (1.50 cm) and number of leaves per plant (19.10) were recorded under G_3 (400 ppm).

For the interaction effects at 60 DAS, the maximum plant height (45.60 cm) and stem base diameter (1.74 cm) were recorded under P_1G_1, whereas the maximum plant spread (1,571.13 cm^2) and number of leaves per plant (25.86) were recorded under P_2G_3.

At harvest, the maximum plant height (36.29 cm), plant spread (1,775.04 cm^2), stem base diameter (1.67 cm) and mean number of leaves per plant (23.37) were recorded under P_2.

Among the GA_3 concentrations at harvest, the maximum plant height (32.37 cm) was recorded under G_2 (200 ppm), whereas the maximum plant spread (1,775.60 cm^2) and stem base diameter (2.05 cm) were recorded under G_3 (400 ppm). The greatest mean number of leaves per plant (23.66) was recorded under G_2.

At harvest, the interaction between leaf pruning and foliar GA_3 application showed that P_2G_3 recorded the maximum plant height (45.72 cm), plant spread (2,180.97 cm^2; Table 1), stem base diameter (2.05 cm) and number of leaves per plant (25.86; Table 2), and was significantly superior to the other treatments for these traits.

The increase in plant height observed in the present study may be attributed to the combined influence of leaf pruning and GA_3 application. Pruning reduces within-plant competition for nutrients and improves light penetration into the canopy, thereby enhancing photosynthetic efficiency and vegetative growth. In addition, GA_3 stimulates cell division and elongation in stem tissues, which can contribute to rapid plant growth and increased plant height. Comparable responses have been reported in muskmelon (Asrey et al., 2001), round melon (Arora et al., 1982), ridge gourd (Hilli et al., 2010), and pumpkin (Sure et al., 2013). Arora and Malik (1989) also reported that pruning influenced growth and flowering in ridge gourd.

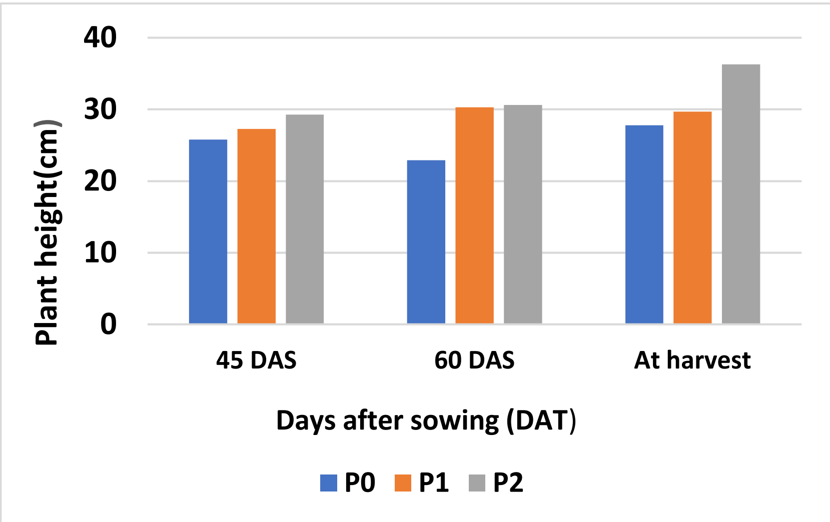

Fig. 1. Effect of leaf pruning on plant height(cm) of summer squash

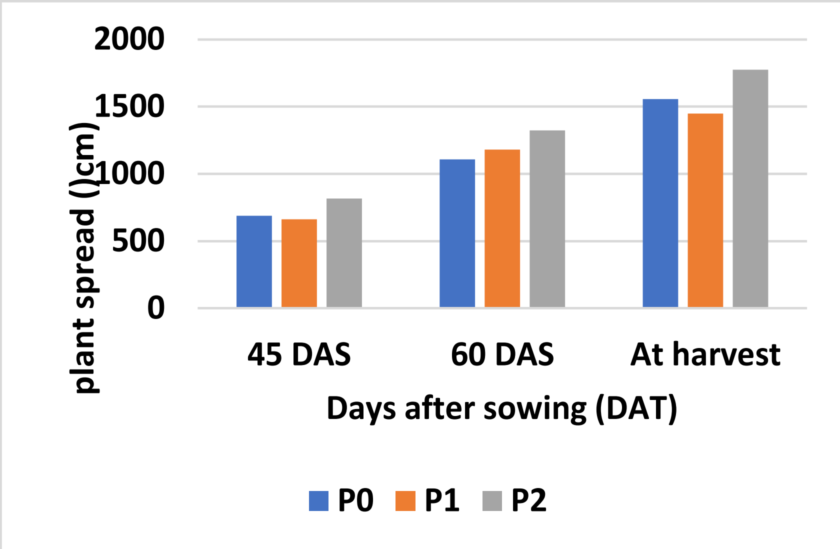

Fig. 2. Effect of leaf pruning on plant spread(cm) of summer squash

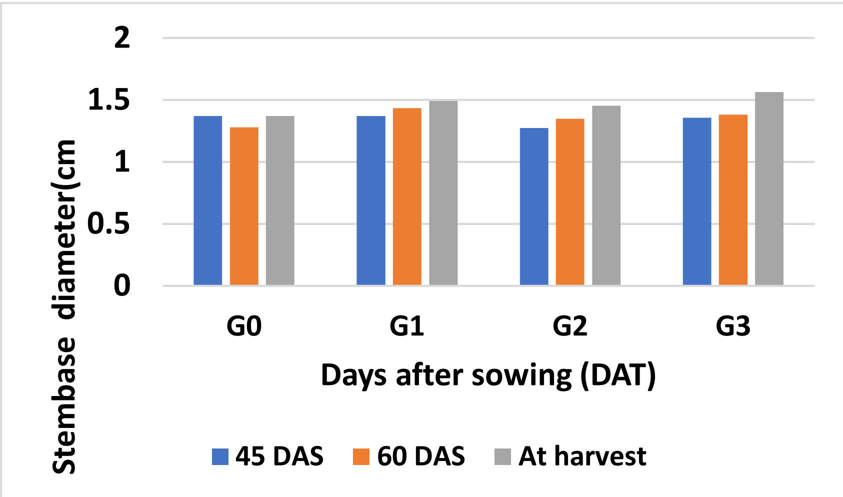

Fig. 3. effect of GA_3 on Stem base diameter (cm) of summer squash

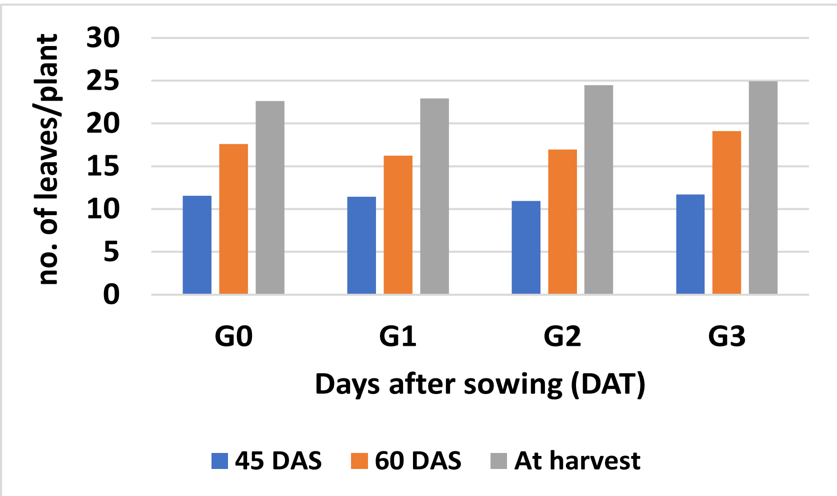

Fig. 4. Effect of GA_3 on Number of leaves/plantsof summer squash

Table 1. Combine effect of leaf pruning and foliar application of on plant height and plant spread at 45 DAS, 60 DAS and at harvest

Factor (A X B)	Plant height (cm)			Plant spread(cm^2)		
	45 DAS	60 DAS	At harvest	45 DAS	60 DAS	At harvest
P_0G_0	20.93	18.33	23.66	928.44	1,144.00	1,449.40
P_0G_1	24.83	21.23	29	821.09	1,114.73	1,761.47
P_0G_2	35.8	35	36.3	459.89	1,036.67	1,399.33
P_0G_3	21.66	17.06	22.26	546.69	1,134.97	1,617.33
P_1G_0	27.4	27.56	30.66	605.84	1,011.93	1,227.67
P_1G_1	35.06	45.6	35.4	687.49	1,107.67	1,550.87
P_1G_2	20.93	20.46	24.4	594.81	1,296.20	1,490.40
P_1 G_3	25.7	27.6	28.33	763.51	1,306.27	1,522.50
P_2G_0	29.16	31.06	35.3	724.25	1,209.60	1,530.60
P_2G_1	24.56	25.66	27.7	753.62	1,263.27	1,695.53
P_2G_2	28.43	29.73	36.43	682.68	1,243.00	1,693.07
P_2G_3	35	35.96	45.72	1,100.78	1,571.13	2,180.97
S. Em ±	0.93	1.08	0.97	34.57	62.04	89.41
C.D. at 5 %	2.75	3.19	2.87	102.06	183.14	263.93

Table 2. Combine effect of leaf pruning and foliar application of GA_3 on stem base diameter and no. of leaves at 45 DAS, 60 DAS and at harvest

Factor (A X B)	Stem base diameter (cm)			Number of leaves/plants		
	45 DAS	60 DAS	At harvest	45 DAS	60 DAS	At harvest
P_0G_0	1.01	1.26	1.16	11.7	10.83	23.26
P_0G_1	1.26	1.26	1.33	9.83	15.6	23.33
P_0G_2	1.54	1.30	1.56	10.86	20.5	23
P_0G_3	1.12	1.27	1.24	10.86	11.7	20.83
P_1G_0	1.267	1.24	1.29	10.83	16.6	23.26
P_1G_1	1.68	1.74	1.64	12.2	21.76	23.33
P_1G_2	1.01	1.34	1.28	11.6	11.13	23
P_1G_3	1.30	1.36	1.39	11.33	19.73	20.83
P_2G_0	1.83	1.33	1.65	12.16	25.36	20.5
P_2G_1	1.16	1.29	1.50	12.3	11.33	21.76
P_2G_2	1.27	1.39	1.50	10.33	19.2	25.36
P_2G_3	1.64	1.50	2.05	12.93	25.86	25.86
S. E±	0.058	0.039	0.063	0.264	0.813	0.671
C.D. at 5 %	0.071	0.116	0.186	0.778	2.400	1.980

The increase in plant spread might be associated with leaf removal during pruning, which can induce a compensatory growth response and stimulate lateral development. Furthermore, GA_3 enhances vegetative growth through increased cell division and elongation, resulting in greater canopy expansion. The interaction between pruning and GA_3 may also influence stem base diameter by modifying plant architecture and resource distribution within the plant. Similar observations were reported by Baby et al. (2021) in summer squash. More generally, judicious canopy pruning has been associated with improved plant productivity (Ghosh & Bera, 2014).

The greater number of leaves recorded in the present study may be associated with foliar GA_3 application, which can accelerate leaf initiation and stimulate physiological activities such as nucleoprotein and carbohydrate synthesis. In addition, pruning can promote the activation of dormant buds and stimulate the production of new leaves as a compensatory response to leaf removal. The combined effect of GA_3 and pruning may therefore enhance leaf production and overall vegetative growth. Similar results were reported by Sure et al. (2013) in pumpkin and Ansari and Chowdhary (2018) in bottle gourd.

3.2 Yield Parameters

The data for the different pruning levels showed that P_2 recorded the greatest number of male flowers (19.64), number of female flowers (2.20), number of fruits per plant (2.13), average fruit weight (148.81 g; Table 3), fruit yield per plot (35.26 kg) and fruit yield per hectare (141.03 q). The maximum polar diameter (6.66 cm) was recorded under both P_1 and P_2, whereas the maximum equatorial diameter (6.77 cm; Table 5) was recorded under P_1. The minimum values were generally recorded under P_0.

Among the GA_3 concentrations, G_3 (400 ppm) recorded the greatest number of male flowers (19.70), number of female flowers (2.30), number of fruits per plant (2.20), average fruit weight (151.12 g; Table 3), polar diameter (6.89 cm), equatorial diameter (6.64 cm), fruit yield per plot (37.78 kg) and fruit yield per hectare (151.15 q; Table 5). The lowest values were generally observed under G_0 (no spray).

The interaction between leaf pruning and foliar GA_3 application showed that P_2G_3 recorded the maximum number of male flowers (22.50), number of female flowers (3.23), number of fruits per plant (3.06), average fruit weight (167.63 g; Table 4), polar diameter

(7.10 cm), fruit yield per plot (39.20 kg) and fruit yield per hectare (156.80 q; Table 6). The maximum equatorial diameter (6.92 cm) was recorded under P_1G_3, whereas the minimum values were generally recorded under P_0G_0 (control).

Pruning may improve plant productivity by directing assimilates towards reproductive growth, thereby increasing flower production in cucumber (Hidayatullah et al., 2013). It can also enhance light penetration and photosynthetic efficiency within the canopy, promote nutrient accumulation, and improve plant vigour, thereby supporting flower formation and fruit set (Baby et al., 2021; Ekwu et al., 2012).

Table 3. Effect of leaf pruning and foliar application of GA_3 on total number of male and female flowers, total no. fruits per plant, average fruit weight on summer squash

Factor A (Leaf pruning)	Total no. of male flowers	Total no. of female flowers	Total no. of fruits/plant	Average fruit weight(gm)
Without pruning (P_0)	17.692	1.817	1.750	119.95
Pruning of 1st & 2nd leaf at 45 DAS (P_1)	18.567	1.975	1.867	136.94
Pruning of 3rd & 4th leaf at 55 DAS (P_2)	19.642	2.200	2.133	148.81
S. Em ±	0.349	0.050	0.083	1.754
C.D. at 5 %	1.031	0.147	0.244	5.177
Factor 2 (Gibberellic acid)	**Total no. of male flowers**	**Total no. of female flowers**	**Total no. of fruit/plant**	**Average fruit weight(gm)**
G_0 (Without spray)	17.80	1.87	1.756	135.24
G_1 (100 ppm)	18.38	1.81	1.856	125.33
G_2 (200 ppm)	18.64	1.90	1.856	129.26
G_3 (400 ppm)	19.70	2.30	2.20	151.12
S. Em ±	0.403	0.057	0.095	2.025
C.D. at 5 %	1.190	0.169	0.282	5.978

Table 4. Combine effect of leaf pruning and foliar application of GA_3 on total number of male and female flowers, total no. fruits per plant, average fruit weight on summer squash

Factor (A X B)	Total no. of male flowers	Total no. of female flowers	Total no. of fruit/plant	Averagefruit weight(gm)
P_0G_0	15.2	1.8	1.7	107
P_0G_1	18.1	1.83	1.76	116.16
P_0G_2	19.267	1.86	1.73	121
P_0G_3	18.2	1.76	1.8	135.66
P_1G_0	19.6	1.9	1.76	150.6
P_1G_1	18.067	2.06	1.96	121.96
P_1G_2	18.2	2.03	2	125.13
P_1 G_3	18.4	1.9	1.73	150.06
P_2G_0	18.6	1.93	1.8	148.13
P_2G_1	19	1.83	1.83	137.86
P_2G_2	18.467	1.8	1.83	141.63
P_2G_3	22.5	3.23	3.06	167.63
S. Em ±	0.698	0.099	0.165	3.507
C.D. at 5 %	2.062	0.294	0.488	10.35

Table 5. Effect of leaf pruning and foliar application of GA_3 on Polar diameter Equatorial diameter Fruit yield/plot, Fruit yield q./ha

Factor A (Leaf pruning)	Polar diameter (cm)	Equatorial diameter(cm)	Fruit yield/plot (Kg.)	Fruit yield q./ha.
Without pruning (P_0)	6.27	6.069	32.183	128.70
Pruning of 1st & 2nd leaf at 45 DAS (P_1)	6.66	6.771	34.133	136.53
Pruning of 3rd & 4th leaf at 55 DAS (P_2)	6.66	6.615	35.258	141.03
S. Em ±	0.089	0.048	0.214	0.855
C.D. at 5 %	0.262	0.141	0.063	2.525
Factor 2 (Gibberellic acid)	**Polar diameter (cm)**	**Equatorial diameter(cm)**	**Fruit yield/plot**	**Fruit yield per ha.**
G_0 (Without spray)	6.43	6.25	30.07	120.31
G_1 (100 ppm)	6.37	6.54	32.05	128.17
G_2 (200 ppm)	6.43	6.50	35.51	142.04
G_3 (400 ppm)	6.89	6.64	37.78	151.15
S. Em ±	0.103	0.055	0.247	0.988
C.D. at 5 %	0.303	0.163	0.730	2.915

Table 6. Combine effect of leaf pruning and foliar application of GA_3 on polar diameter, equatorial diameter, fruit yield per plot and fruit yield per ha. on summer squash

Factor (A X B)	Polar diameter (cm)	Equatorial diameter(cm)	Fruit yield/plot(kg)	Fruit yield/ha. (q.)
P_0G_0	6.307	6.043	28	112
P_0G_1	6.067	6.097	31.16	124.66
P_0G_2	6.22	6.03	32.73	130.93
P_0G_3	6.487	6.107	36.83	147.33
P_1G_0	6.953	6.6	31.53	126.13
P_1G_1	6.283	6.867	32.86	131.46
P_1G_2	6.343	6.697	34.8	139.2
P_1 G_3	7.087	6.92	37.33	149.33
P_2G_0	6.04	6.107	30.7	122.8
P_2G_1	6.78	6.673	32.13	128.53
P_2G_2	6.733	6.78	39	156
P_2G_3	7.1	6.9	39.2	156.8
S. Em ±	0.178	0.09	0.428	1.711
C.D. at 5 %	0.525	0.28	1.264	5.049

Improved light distribution and air circulation following pruning can support fruit development, leading to greater fruit weight and size, including increased polar and equatorial diameters (Ekwu et al., 2012; Gobeil & Gosselin, 1989; Suthar et al., 2006). Better air movement within the canopy may also reduce disease incidence and improve fruit quality and yield (Tang et al., 2010).

Application of GA_3 influences flowering behaviour in cucurbits by modifying hormonal balance and sex expression. Similar responses have been reported in bitter gourd (Hossain et al., 2006), cucumber and bitter gourd (Khan & Chaudhry, 2006), and summer squash (Dobhal et al., 2022).

The combined application of GA_3 and pruning may enhance reproductive growth, reduce flower abortion, improve fertilisation, and increase fruit number and size, thereby contributing to healthier plants and greater yield (Baqi et al., 2018; Tang et al., 2010).

3.3 Quality Parameters

Among the pruning levels, P_1 recorded the highest total soluble solids (3.54 °Brix), the lowest moisture content (93.75%) and the highest fruit dry weight (6.24 g/100 g), whereas P_2 recorded the highest ascorbic acid content (15.42 mg/100 g).

Among the GA_3 concentrations, the highest total soluble solids (3.74 °Brix) were recorded under G_2 (200 ppm), and the highest ascorbic acid content (13.61 mg/100 g) was recorded under G_1 (100 ppm). The lowest moisture content (93.48%) and the highest fruit dry weight (6.52 g/100 g) were recorded under G_0.

The interaction between leaf pruning and foliar GA_3 application showed that the highest total soluble solids (4.06 °Brix) were recorded under P_1G_2, and the highest ascorbic acid content (19.61 mg/100 g) was recorded under P_2G_1. The lowest moisture content (90.84%) and the highest fruit dry weight (9.15 g/100 g) were recorded under P_1G_0.

Table 7. Effect of leaf pruning and foliar application of GA_3 on TSS, Ascorbic acid, Dry weight and Moisture content summer squash

Factor A (Leaf pruning)	TSS (°Brix)	Ascorbic acid) (mg/100gm)	Dry weight of fruit (gm)	Moisture content (%)
Without pruning (P_0)	3.31	9.98	4.77	95.22
Pruning of 1st & 2nd leaf at 45 DAS (P_1)	3.54	12.96	6.24	93.75
Pruning of 3rd & 4th leaf at 55 DAS (P_2)	3.43	15.42	3.88	96.113
S. Em ±	0.055	0.125	0.136	0.136
C.D. at 5 %	0.162	0.370	0.403	0.401
Factor B (Gibberellic acid)	**TSS (°Brix)**	**Ascorbic acid (mg/100gm)**	**Dry weight of fruit (gm)**	**Moisture content (%)**
Control (G_0)	3.22	13.02	6.52	93.48
100 ppm (G_1)	3.44	13.61	3.60	96.39
200 ppm (G_2)	3.74	11.57	4.29	95.7
400 ppm (G_3)	3.31	12.97	5.44	94.56
S. Em ±	0.063	0.145	0.158	0.157
C.D. at 5 %	0.187	0.427	0.465	0.463

Pruning improves light penetration, air circulation and resource allocation, which may enhance sugar accumulation, vitamin C synthesis and dry-matter content in fruits while maintaining an appropriate moisture balance (Baby et al., 2021; Bhagawati et al., 2015; Ghosh & Bera, 2014). GA_3 stimulates cell division, vascular development and metabolic activity and may influence enzymes involved in carbohydrate and ascorbic acid biosynthesis, thereby affecting total soluble solids and nutrient content (Pandey et al., 2021; Gilani et al., 2021). However, the response of fruit dry matter and water content to GA_3 may vary with concentration and crop conditions (Pal et al., 2016). The combined use of GA_3 and pruning may balance vegetative growth and resource allocation, thereby influencing total soluble solids, ascorbic acid, dry matter and moisture content in a treatment-specific manner (Baby et al., 2021; Dobhal et al., 2022).

Table 8. Combine effect of leaf pruning and foliar application of GA_3 on TSS, Ascorbic acid, Dry weight and Moisture content summer squash

Factor (A X B)	TSS (°Brix)	Ascorbic acid (mg/100gm)	Dry weight of fruit (gm)	Moisture content (%)
P_0G_0	3.03.	9.98	5.58	94.41
P_0G_1	3.06	9.43	3.13	96.89
P_0G_2	4.02	9.503	4.67	95.31
P_0G_3	3.15	11.02	5.71	94.28
P_1G_0	3.37	12.12	9.15	90.84
P_1G_1	3.33	11.79	4.68	95.32
P_1G_2	4.06	13.41	4.40	95.59
P_1 G_3	3.4	14.53	6.72	93.27
P_2G_0	3.26	16.94	4.82	95.17
P_2G_1	3.93	19.61	3.04	96.96
P_2G_2	3.13	11.78	3.79	96.20
P_2G_3	3.4	13.35	3.89	96.11
S. Em ±	0.110	0.251	0.273	0.272
C.D. at 5 %	0.324	0.740	0.806	0.801

4. Conclusion

Leaf pruning and foliar GA_3 application influenced the growth, yield and quality attributes of summer squash cv. Pusa Pasand under the Himalayan valley conditions evaluated. The P_2G_3 treatment, involving removal of the third and fourth leaves at 55 DAS followed by 400 ppm GA_3, produced the strongest overall growth and yield response. This combination recorded the highest plant height, plant spread, stem base diameter, leaf number, male and female flower numbers, fruits per plant, average fruit weight, plot yield and yield per hectare. Nevertheless, the fruit-quality attributes did not respond uniformly to P_2G_3. Maximum total soluble solids were obtained under P_1G_2, maximum ascorbic acid content under P_2G_1, and maximum dry weight together with minimum moisture content under P_1G_0. The findings therefore support P_2G_3 as the most promising treatment for improving summer squash yield under the conditions of the study. Selection of a treatment for quality enhancement should, however, be based on the specific quality attribute targeted. Validation across additional seasons and comparable Himalayan valley environments would strengthen the applicability of these findings.

5. Limitations

The experiment was conducted during one summer season at a single Himalayan valley location and evaluated only one summer squash cultivar. Consequently, seasonal, site-specific and cultivar-related variation could not be assessed. The treatment range was limited to three pruning regimes and four GA_3 concentrations, and the quality traits showed different optimum treatment combinations.

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Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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