

IMPACT OF PRUNING LATERAL BRANCHES ON YIELD AND ANATOMICAL FEATURES OF PISUM SATIVUM L. (INDIAN VARIETY): A STUDY OF MECHANICAL STRESS EFFECTS

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Abstract

The garden pea (*Pisum sativum* L.) is cool-season legumes with both nutritional and agronomic importance, which are often limited due excessive vegetative growth or inadequate assimilate partitioning. Although pruning side branches is a low-cost way to help the plant put more energy into yield, its effects on pea production and stem anatomy are still not well understood. The study compared effects of pruning on growth, yield and anatomical traits of *P. sativum* L [Indian variety] conducted from October 2023- May 2024. The experiment was conducted in Randomized Complete Block Design with seven treatments comprising of three replications each. Schematic view of the treatments applied: main stem without lateral branches (T1) and one (T2), two (T3), three (T4), four (T5) and five lateral branches (T6). Control (T0) was the un-pruned plants. Growth, yield components and stem anatomical data were collected and analyzed by two ways ANOVA. Results indicated that T3 resulted in the highest amount of biological yield per plant as well as a significant increase in number of pods per plant, seeds weight in grams (mg) and seeds per pod. Pruning also improved plant height, and 100-seed weight but decreased shoot fresh and dry weights compared to the unpruned control. The impact of pruning on anatomical characteristics was found non-significant in all the treatments. The data indicate that rational structural pruning of lateral branches at specific level can enhance growth and productivity in *P. sativum*.

Keywords

Anatomical characteristics, Lateral branches, Pruning, *Pisum*, RCBD, Yield.



1.Introduction

Cultivated garden pea (*Pisum sativum* L.), a member of the family Fabaceae, is one of the most important cool-season legume and vegetable crops (Wu *et al.*, 2023). Commercially, it is appreciated due to its high nutritional value as boiled seeds are rich profitable protein sources which include significant levels of essential amino acids and carbohydrates with low fat content (Singh *et al.*, 2021; Qin *et al.*, 2024). In addition to being a direct edible source, pea aids sustainable agriculture through biological nitrogen fixation (Ibrahim *et al.*, 2022; Kaziūnienė *et al.*, 2025; Kassahun *et al.*, 2025), improved soil structure, and as a crop rotation using green manure and cover crop (Singh *et al.*, 2021). Pea is grown on a wide area in Pakistan with 402.000 metric tons coming into production by 2022–2023 (Usman *et al.*, 2025). Insights into management practices to improve pea yield and quality are of great importance considering its nutritional and agronomic significance. Mechanical stress is an environmental factor that can affect plant growth and development (Kouhen *et al.*, 2023). This happens naturally by wind and the movement of plant organs, but it can also be intentionally done by growers with rubbing, bending, shaking or pruning (Cao *et al.*, 2022; Yang *et al.*, 2023). When pruned, a mechanical stress opportunity is created which has been shown to be able to modulate physiological responses beneficial for productivity in several crops (Hansen *et al.*, 2025). For instance, pruning with chemicals has been reported to improve yield in guava while root pruning increased root dry weight in ornamental species (Gomasta *et al.*, 2024). These results show that mechanical stress, especially pruning can significantly influence growth and productivity (Feng *et al.*, 2022; Wang *et al.*, 2021). On the other hand, plant responses

to pruning were not uniform and varied widely between species and according to treatment type. Although the role of mechanical stress on multiple crops has been investigated, but little is known about the growth, yield and anatomical traits in *P. sativum* when subjected to pruning. However, the impact of pruning regimes on epidermal traits of pea stems has not been studied. To see if pruning could be a viable tool to enhance field performance with peas, you need a clearer picture of these responses.' Hence, the objective of the present study was to determine the influence of kinds pruning treatments on *P. sativum* L. [Indian variety]. The aims were: 1) to study the impact of pruning on yield; 2) to analyze changes in morphological traits; and 3) to observe anatomical variations of stem cross-sections under pruning treatments. Results from this research should contribute to a fundamental understanding of mechanical stresses in pea and provide guidelines for optimizing pruning practices to maximize yield and quality.

2.Materials and Methods

2.1 Experimental site and plant material

Field experiment was performed at agricultural farm, Yazman, Bahawalpur, Pakistan (latitude 27.40°–29.50° N and longitude 70.54°–72.50° E) during the growing season of 2023–2024 where seeds from an Indian cultivar of pea (*Pisum sativum* L.) were sown on 30 October 2023 with first germination recorded on 4 November 2023 (five days after sowing). On 28 January 2024, three months after sowing or approximately 90 days, when pods contained seeds that were approximately 80–90% brown/grey (the life cycle is complete after this time; the seeds will turn dark and germinate), the crop was harvested. Research

into the impact of pruning in pea has previously been sparse. Hence, the current experiment was planned for investigating the impact of mechanical stress (pruning) on anatomical traits and yield of pea at Bahawalpur local climatic conditions.

2.2 Experimental design

The experiment was arranged in a randomized complete block design (RCBD) with seven treatments and three replications (Baral *et al.*, 2022). Each replication included five plants. This was performed on November 20th, where the net plot size was 3 m × 7 m (21 m²). Seeds were planted 2 inches from each other at a depth of 1 to 1.5 inches in a ridges-and-furrows layout spaced 20 inches apart in rows. Standard agronomic practice in up-field pea production was followed for the entire growing season.

2.3 Pruning treatments

Four weeks after seed germination on 5 December 2023, when plants had produced an adequate number of lateral branches, pruning treatments were applied (Zhong *et al.*, 2024). The treatments were seven combinations defined as the number of lateral branches retained in the stem principal: T0: un-pruned plants (control) T1: unbranched main stem T2: main stem + 1 lateral branch T3: trunk and two side branches T4: main stem with 3 lateral branches T5:

one main stem with four lateral branches T6: stem with 5 lateral branches The main stem retained only nodes matching the number of lateral branches per treatment. They were pinched off regularly all additional lateral branches that grew up during the growing period.

2.4 Soil analysis

Soil samples were taken from the experimental field before sowing with the help of a soil auger and these were sent to Soil and Water Testing Laboratories for Research, Bahawalpur. The samples were classified as loamy soil, and reported strongly saline soil properties with means of 3.4 & 3.9 dS/m electrical conductivity; 7.9 pH; 0.45% & 0.52% organic matter; 5.3 & 4.6 ppm available phosphorus; 268 & 239 ppm available potassium for every sample; and 34% & 35% saturation percentage for each sampled respectively (Table1).

Table 1

Regd. No.	Detail Sam	Depth (inches)	E.C. dS/m	p H	Organic Matter %	Phosphorus content (ppm)	Available Potassium (ppm)	Saturatio n %age	Textural Class	Remarks
862	1	0-6	3.4	7	0.45	5.3	268	34	Loam	Normal soil
				.						
				9						
862	2	0-6	3.9	7	0.52	4.6	239	35	Loam	Normal soil
				.						
				9						

2.5 Crop management

At sowing, the plot was inundated with water and subsequently watered twice weekly, using buckets at doses of equal volume to each row. No additional nitrogen fertilizer was applied as legumes plant can fix their atmospheric nitrogen because of the high sensitivity to the availability of soil-based nitrogen; instead, 300 kg cow dung mixed with the soil before sowing without other fertilizers. Pesticides were not used; sporangial fruiting bodies were handpicked and any weeds emerging in the experimental field were also picked. Plants were observed daily throughout the experiment for visible disease symptoms. No disease symptoms were observed on leaves and stems of any plants. Moreover, no visible disease symptoms were observed on the roots at the time of harvest.

2.6 Harvesting

Plants were harvested on 28 January 2024 when, at least 80% of seeds inside pods were brown and grey in color.

2.7 Morphological and yield characteristics

All evaluated yield traits were determined at the conclusion of the experiment: plant height (final); number of pods per plant; seed size (width and breadth); seed colour; seed shape; pod size (length and width); pod colour; number of seeds per plant; number of seeds per pod; 100-seed weight (g); seeds weight/plant (g); fresh/dry weight shoots [stem + leaves] (g. in wet basis) / dry mass basis); fresh/dry weights roots [g in wet basis g. in dry mass basis]; biological yield/plant (g). All plants of each replication from each treatment at the complete maturity (just before the time of harvesting) were selected and final height was measured in cm from the surface/ground level to the apex of main stem of plant by measuring

tape. Pod number was counted from all plants/replication. Seed size (length and width) determined with a micrometer; seed colour and form were documented by visible watching (all seeds were yellowish green and round). Pod length (tip to base) and breadth were recorded for all the pods per replication which were averaged; pod colour was visually scored (all pods are lush green). We counted seed number per plant and per pod on the all plants and pods, respectively. One hundred-seed weight was measured by weighing 100 seeds each per replication with an electrical balance. Seed weight per plant was determined by weighing all seeds belonging to a plant using an electrical balance. Following harvest, fresh shoot and root weights were recorded immediately after the crop was harvested while dry weight input values of variants with identical cultivation period were also recorded from one-week sundry. After one week of sun drying, all plant parts (shoots, roots, seeds and empty pods) were weighed to determine biological yield per plant with the mean values calculated across the sampled plants per replication.

2.8 Anatomical observations

To avoid tissue damage, the stem segments excised at harvest were fixed in FAA (formalin–acetic acid–alcohol; 5% formalin, 5% acetic acid and 90% alcohol) for further study (Miya *et al.*, 2024). Due to the hardening of harvested stems, sections were softened in boiling water for one hour before being cut. Subsequently, free-hand cross-sections were cut with a razor blade using a potato block to support the tissue and were transferred to water by means of a brush (Tran *et al.*, 2024). The thinnest and finest sections were then picked out for slide preparation. Dehydration of sections and staining The sections

were placed in a glass watch, dehydrated with 10–15 drops of absolute ethanol for 1 hour and stained in a solution of toluidine blue O (0.1 g toluidine blue dissolved in 100.0 mL distilled water) for 10 minutes (Tran *et al.*, 2024). Following removal of dye, sections were washed several times with distilled water, and immersed in 10–15 drops of 96% (v/v) ethanol for one minute then set on the slides. After application of a drop xylene–Canada balsam mixture, the section was sealed with cover slip (Zhang *et al.*, 2022). The anatomical characteristics of stem cross-sections such as stem area, epidermis thickness, cortical thickness, sclerenchyma thickness, hollow pith area, number of vascular bundles and their respective xylem and phloem thicknesses or areas were analyzed under light microscopy and photomicrographs were obtained using a digital camera attached to the microscope eyepiece. Stem sections were examined under a light microscope at 4x and 40x magnification. Five plants were sampled per replication, one finely make slides with properly cut sections is prepared from one plant resulting in 5 slides per replication. Measured from five slides is used in calculating a mean and is used in further statistical analysis for each parameter measured. Images were captured and calibrated by an ocular micrometer with scaled conversions of $0.9\text{cm} = 100\mu\text{m}$ at 4x and $9.2\text{cm} = 100\mu\text{m}$ at 40x equating to $111.11\mu\text{m cm}^{-1}$ and $10.869\mu\text{m cm}^{-1}$, respectively.

2.9 Statistical analysis

The 7 different pruning field experiments were conducted in RCBD with 3 replications in each. In

each replication, the number of plants that were growing in replication at a time was 5, and all the measurements of all parameters and all replications were measured. Mean values of replication for the analysis were calculated. The data generated was analyzed with two-way ANOVA RCBD model by using MSTAT-C software (Helal *et al.*, 2023). The replication was taken on assumption of blocks. The degree of freedom was 12 and the Least Significant Difference (LSD) test at 5% α level of significance was applied. The graphical demonstration of the field experiment readings was made by using Microsoft Excel 2021 (Church *et al.*, 2022) and IBM SPSS Statistics version 29.0 software (Almubarak *et al.*, 2025).

3. RESULTS AND DISCUSSION

3.1. Yielding Characteristics

3.1.1 Effect of Pruning Treatments on Plant Height at harvest

Figure 1 shows the effects of the seven pruning treatments on final plant height. T5 increased 25.53 cm in height; T1 produced the shortest plants (21.73 cm). However, the LSD of 5.640 ($\alpha = 0.05$) indicates that none of these differences were statistically significant (means $\pm$ SE, $df = 12$), suggesting that height variation was not strongly driven by pruning regime. This finding was similar to Moosavi *et al.*, (2024) who found pruning seedlings during a drought led to increased height growth the following summer but observed variable stem dieback in unpruned seedlings.

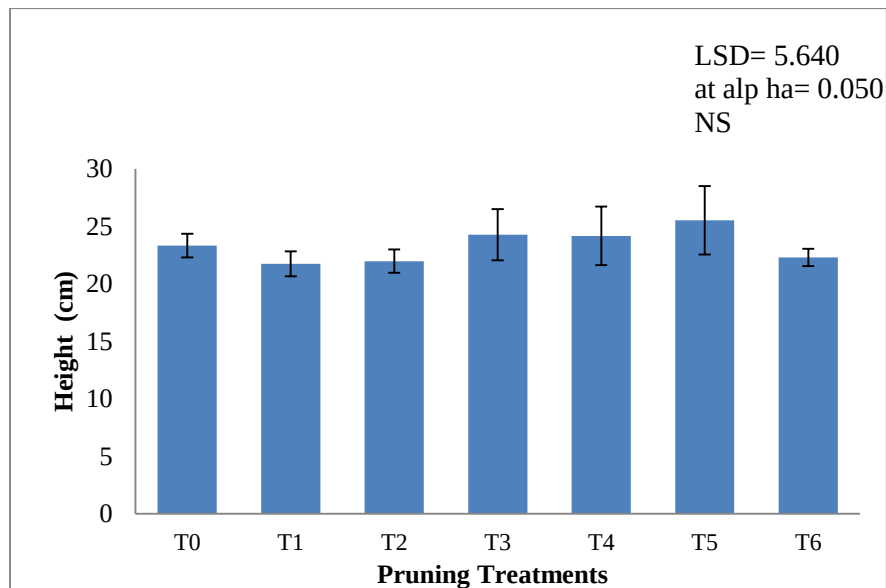


Fig 1. Mean final plant height under seven pruning treatments at harvest, all ANOVA values are same “a” which are non-significant (NS)

3.1.2 Effect of pruning treatments on pods features

The data were analyzed through seven treatments, and the effects of different pruning treatments on number of pods, pod length and pod width per plant. As shown in Fig 3.2. With respect to the number of pods per plant, in Figure 3.2(a), treatment T3 was responsible for the highest pod counts, with an average of 5.100 pods. Conversely, treatment T2 had the lowest value of upper pods: 2.867. There was no significant difference between treatments ($\alpha = 0.050$; $LSD = 1.235$, $df = 12$). Pod length data is depicted in the Figure 3.2(b) for treatments T1 has longer average pod length of 4.126 cm. The average pod length was also shorter for all types with Treatment T6 being the shortest (3.798 cm). No significant differences among treatments on pod length were found at $\alpha = 0.050$ ($LSD: 0.5846$). The pod width results are presented in Fig. 3.2(c). Comparatively, treatment T2 had the widest pods (1.206 cm) which was not statistically significant from treatment T3 whereas the narrowest

pods were obtained from treatment T4 (1.067 cm). At $\alpha = 0.050$, the LSD for pod width was 0.1779, which also indicated no significant difference among treatments ($df = 12$). The maximum pod production observed in treatment T3 indicates that a less closed canopy structure might facilitate more light penetration and air flow, which could lead to better pod filling (Priyadarsini *et al.*, 2025). It is probable that the longest pods obtained with treatment T1 were due to good resource allocation and favorable growth conditions offered by this pruning method. Greatest pod width was in treatment T2 shown that this method of pruning could induce greater expansion of pods. On the other hand, there were few statistically significant differences across treatments suggesting that some trends may be monitored but in general pruning has little impact on pod dimensions and could potentially depend on environmental or genetic factors (Tosto *et al.*, 2022; Javaid *et al.*, 2022; Kilbarena *et al.*, 2023; Javaid *et al.*, 2024; Hadid & Toknok, 2025). Additionally, this study emphasizes the need for the

careful selection of appropriate pruning strategies to maximize pod yield in crops (Tosto *et al.*, 2022; Esche *et al.*, 2023; Kilbarena *et al.*, 2023; Tustiyan *et al.*, 2024). Future studies can investigate the biological

mechanisms that underlie these different doses of pruning and evaluate the effects of multiple years of pruning on growth, health and productivity.

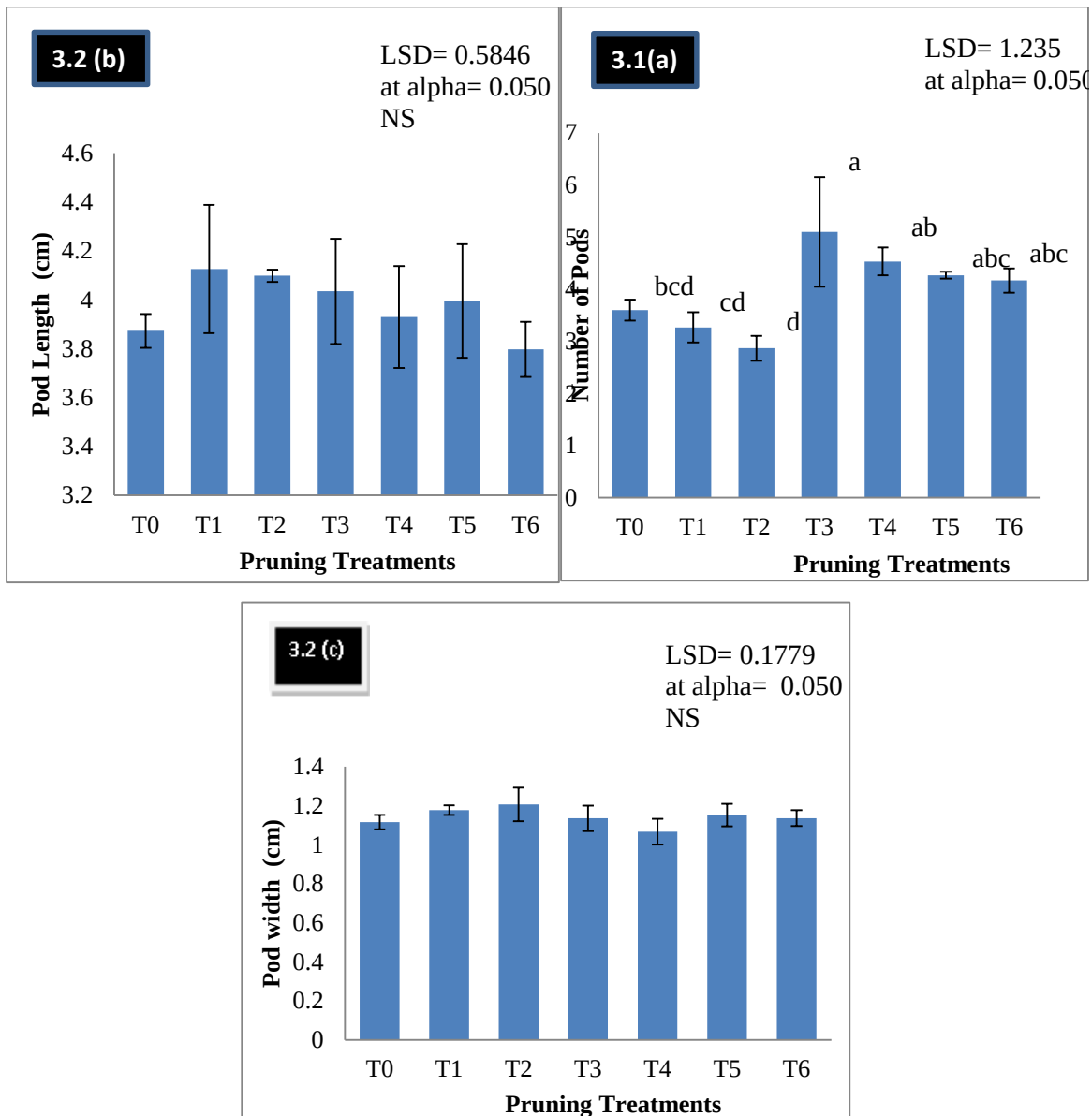


Fig.2: Effect of pruning treatments on (a) Number of pods per plant, (b) Pod length (all ANOVA values are same “a” which are NS), (c) Pod width (all ANOVA values are same “a” which are NS)

3.1.3 Influence of Pruning Treatments on Seed Features

Treatment T1 had the highest value of seed width (0.8583 with LSD 0.2639 at alpha level: 0.050), while treatment T0 recorded the lowest value of seed width (0.6701). Likewise, T1 had the widest seed breadth at 0.5181 cm and T0 had the lowest breadth seeds at 0.3944 cm as well with a LSD worth of 0.2105 on an indistinguishable alpha level ($\alpha=0.05$). As for number of seeds per plant, treatment T3 had the most with 7.467 while treatment T2 had the least amount of seeds with 5.367 (1.538 LSD, $\alpha=0.05$). In relation to the number of seeds per pod (less time for treatments with more number), treatment T3 in plenty stood out, being

Table 2

higher than the others with 3.933 and treatment T1 had lower rates with 3.133 (LSD=04089 at $\alpha=0.050$). The weight of seeds per plant ranged from 0.3200 (T1) grams to 0.7833 (T3) grams; at alpha level = 0.050 with LSD value was equal to 0.3232. In addition to that, treatment T2 also resulted in the highest 100-seed weight (14.67 g) while treatment T3 had the lowest (11.04 g) with LSD value of 4.603 at alpha level of 0.050 Means $\pm$ SE (degrees of freedom 12). Comparison of different seed traits on the seven pruning treatment of seed width, seed breadth, number of seeds per plant, number of seeds per pod and Weight in gram (g) of seeds per plant and 100-seed weight are shown in

Table 2 Comparison of seed characteristics in pruning treatments

Treatment	Seed size		No. of seeds per Plant	No. of seeds per Pod	100 seed weight (gm)	Weight of seeds per plant (gm)
	Seed Width (cm)	Seed Breadth (cm)				
T0	0.6701 a	0.3944 a	7.067 ab	3.433 bc	14.17 a	0.6267 ab
T1	0.8583 a	0.5181 a	5.633 bc	3.133 c	13.8 a	0.32 b
T2	0.7525 a	0.4798 a	5.367 c	3.467 bc	14.67 a	0.4467 b
T3	0.7685 a	0.4533 a	7.467 a	3.933 a	11.04 a	0.7833 a
T4	0.7501 a	0.4104 a	6.6 abc	3.6 ab	12.29 a	0.5433 ab
T5	0.7939 a	0.5088 a	6.5 abc	3.3 bc	13.73 a	0.4333 b
T6	0.8406 a	0.4895 a	5.933 abc	3.2 c	13.03 a	0.3667 b

(Note: Lowercase letters represents statistical significance groupings, same letters show non-significant difference, and different letters show significant difference.) Hence the responses to pruning treatments are important for understanding how lateral branch configurations can affect seed characteristics in *P. sativum*. The highest seed width and seed breadth was observed for the treatment T1. These observations indicate that lateral growth restriction might foster seed size formation, possibly by enhancing resource allocation to the main stem and its fruitful structures (Boccaccini *et al.*, 2024). On the opposite side, T0 expressed the lowest measurements of seed width and breadth, suggesting that without pruning branches may start competing for resources (Nikzad & Baydar, 2023) thus prohibiting proper development within seeds (Rathour *et al.*, 2023). The highest seeds per plant and seeds per pod were obtained in T3 for both objectives, which resulted in the higher seed production. This also suggests that an intermediate level of branching may maximize resource allocation and consequently reproductive output (Nie *et al.*, 2021; Avigal *et al.*, 2022; Arunyanark *et al.*, 2025). The number of seeds was significantly higher in T3 compared to T2 and T1, suggesting that this approach could help plants balance the trade-off between vegetative growth and reproductive success through strategic pruning. In fact, the increment in number of lateral branches did reduce seed production in treatments T4, T5 and T6 which suggests that over branching might lead to diminishing returns. This could be the result of competition for resources (nutrients and light) between the branches resulting in an overall decrease in reproductive efficiency (Rathour *et al.*, 2023; Nikzad & Baydar, 2023). This highlights the key role of the pruning strategy on

enhancing seed properties (Nie *et al.*, 2021; Avigal *et al.*, 2022; Arunyanark *et al.*, 2025). Therefore, a moderate pattern probably offers the most suitable as good compromise to get better dry weight of seeds. Future studies could investigate the physiological mechanisms responsible for these observations, and how this variation may be integrated with practical approaches in agricultural systems to increase crop yields.

3.1.4 Effect of Pruning Treatments on Fresh and Dry weight of Shoots and Roots per Plant

Fresh weight of shoots were significantly the highest for control (T0) (2.647 g) and the lowest in treatment T1 without lateral branches (1.420 g) (Figure 3.3). The idea with this tendency is that lateral branching provides a key role in increasing the vegetative biomass of the plant as a whole (Arunyanark *et al.*, 2025). Lateral branches most probably increase the photosynthetic surface area, resulting in increased light capture and thus higher biomass accumulation (Nie *et al.*, 2021). For this comparison, the Least Significant Difference (LSD) was determined to be 1.030 at $\alpha = 0.050$ suggesting that differences are statistically significant and supports un-pruned plants effectively utilizing the growth potential provided by lateral branches (Avigal *et al.*, 2022). Treatment T6 had the highest fresh weight of 0.4933 grams, while treatment T3 had the lowest with 0.3600 grams (LSD value for root weight = 0.1591 at alpha level). The results also show statistical significance between the treatments. This suggests that shoot biomass appears maximised by un-pruned plants while increased lateral branching is beneficial for root biomass (Avigal *et al.*, 2022). The increase in root growth system among T6 can be due to the fact that a higher shoot system needs

to be supported, as well as the root to shoot ratio. This indicates more efficient use of water and nutrients by plant (Xu *et al.*, 2021). The results for dry weight are shown in Fig 3.3 and matched fresh weight shoot, with T0 having the highest (0.9400 grams) and T1 showing the lowest amount of dry mass produced (0.5200 grams). $LSD = 0.2756$, which indicates that pruning affects the accumulation of the biomass in the shoots very much. The increased dry weight of the un-pruned plants implies that the energy going into lateral branch development in pruned treatments may come at a cost to overall shoot biomass, since the resource must come from elsewhere (Nie *et al.*, 2021; Avigal *et al.*, 2022). In the case of root dry weights, treatment T6 had the highest mean value 0.3333 g and in contrast to treatment T0 lowest 0.1667 g as shown in LSD at 0.09744 This surprising finding could suggest that by having multiple lateral branches, shoot growth is not

only enhanced but perhaps this creates the opportunity for better root development in terms of being able to explore more soil and obtain nutrients (Tosto *et al.*, 2022; Kilbarena *et al.*, 2023; Hadid & Toknok, 2025). The values of degrees of freedom ($df = 12$) for some non-significant differences show that their value is not detectable by the statistics, as obvious trends trade. This strengthens the importance of knowing how to optimize shoots and root development relative to pruning practice ultimately in order to improve plant growth (Mathiyazhagan *et al.*, 2021). Further studies can also look at the physiological basis of these responses, and whether different pruning practices have both immediate and longer term consequences for plant health and yield.

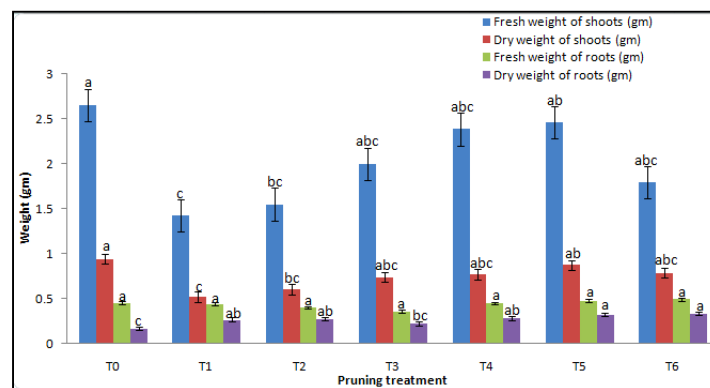


Fig 3. Effect of Pruning Treatments on Fresh and dry Weight of Shoots and roots per plant

3.1.5 Effect of Pruning Treatments on Biological Yield per plant

The results indicate a notable variation in biological yield per plant across the different pruning treatments (Fig 3.4), with treatment T3 achieving the highest yield, yielding 10.89 grams per plant. On the other hand, treatment T4 with 6.567 grams per plant was recorded the least biological yield. The LSD

determined for this analysis was 5.878 at an alpha level of 0.050, which suggests that the treatment differences in biological yield are statistically significant. The interpretation of this result is consistent with the conclusion that a moderate amount of lateral branching may provide the most favorable conditions for efficient resource allocation and maximum whole-plant productivity (Nie *et al.*, 2021; Avigal *et al.*,

2022; Rodrmiguez *et al.*, 2023; Arunyanark *et al.*, 2025). The increase in biological yield observed in T3 might be determined by the proportion of shoot and root growth; thus, having two lateral branches would favor a high production without resource extraction from vegetation (Hadid & Toknok, 2025). On the other hand, treatment T4 had a smaller biological yield. This reduction can be attributed to the depletion of resources (as the competition between branches is probably greater) and consequent inefficiency of

growth. Higher number of lateral branches could pay higher energy leading to sacrifice in total biomass accumulation. This phenomenon indicates that we need to balance the branching sufficiently in order to obtain maximal yield. The average difference between groups (T3 against T4) is statistically significant (LSD = 5.878), suggesting that excess of lateral branching can reduce biological yield (Tosto *et al.*, 2022; KilbarenA *et al.*, 2023; Javaid *et al.*, 2023).

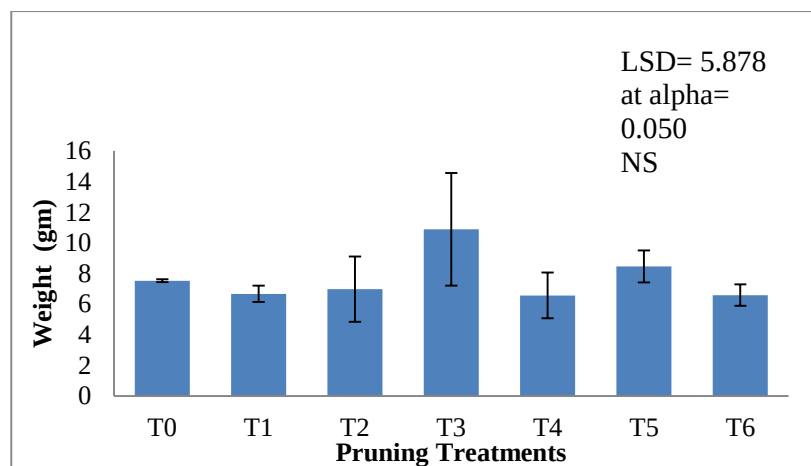


Fig 4: Effect of Pruning Treatments on Biological Yield per plant (all ANOVA values are same “a” which are NS)

3.2 Effect of pruning treatments on anatomical characteristics of *P. sativum*

The outcomes of this study offer significant findings on the anatomical responses of *P. sativum* to growth following differential pruning treatments. Different treatments, based on the level of lateral branching, affected specific anatomical traits (Fig 3.5 & Fig 3.6), and these responses can be discussed in reference to growth and resource allocation in plants. Table 3.2 describes the effects of Pruning Treatments on the Anatomical characteristics of *P. sativum*. The characteristics inculcated in the measurement involved stem area, epidermis, cortical thickness, sclerenchyma thickness as well as pith area number of vascular

bundles dissected per plant and this has been confirmed by xylem and phloem thicknesses along with their respective areas. The maximum value of stem area ($3507.77 \mu\text{m}^2$) and pith area ($1842.961 \mu\text{m}^2$) was found in the treatment T4, whereas the minimum values for stem area $2202.03 \mu\text{m}^2$ and pith area $1004.258 \mu\text{m}^2$ was obtained in T0 respectively. At an alpha value of 0.050, the LSD values for stem area and pith area were $14.96 (\pm \text{SE}, \text{df} = 12)$ and $8.171 (\pm \text{SE}, \text{df} = 12)$, respectively indicating non-significant differences. The maximum Epidermis thickness ($10.9274 \mu\text{m}$) was obtained at Treatment T1, while T4 had the lowest value ($6.1644 \mu\text{m}$). The most reached value of Cortical thickness was in treatment T5

(21.07 μm), and the least in T1 (12.10 μm). The LSD (alpha, 0.050) for epidermis thickness and cortical thickness were 0.2698 ($\pm$ SE, df = 12) and 0.3898 ($\pm$ SE, df = 12), respectively; differences across species were not significant between all species combinations. Treatment T6 produced maximum sclerenchyma thickness (22.1911 μm) and minimum was observed in treatment T4 (14.1216 μm). The LSD value was 0.7004 at an alpha level of 0.050, indicating non-significant differences ($\pm$ SE, df = 12). The highest and lowest number of vascular bundles was observed in T2 (15.00) and T1 (13.00), respectively. The alpha level was 0.050 and the LSD value was 1.893, revealing non-significant differences ($\pm$ SE, df = 12). The vascular area was greater in T1 (212.6046 μm^2) and lower in T2 (110.4851 μm^2). At alpha = 0.050, LSD value was 6.769 with non-significant differences (df =

12). Xylem thickness was 40.5725 μm in T1 as the highest value, but the lowest is T4 with 26.5621 μm . LSD value 0.5927 identified by areas as statistically non-significant differences. Maximum phloem thickness recorded was in treatment T6 (12.54 μm) followed by treatment T2 being the lowest (5.55 μm). At an alpha level of 0.050, the LSD value was only 0.4774 and differences were not significant (df = 12). Statistical analysis revealed that the all the differences among the pruning treatments were found to be non-significant at alpha 0.05. This indicated that pruning of lateral branches do not have a substantial impact on the anatomical features of *P. sativum*. Similar results were observed by Leng et al., (2025) that pruning had no significant impact on the anatomical characteristics of *Populus deltoids*.

Table 3: Effect of pruning treatments on anatomical characteristics of *P. sativum*

Treatment	Stem Area (μm^2)	Epidermis Thickness (μm)	Cortical Thickness (μm)	Sclerenchyma Thickness (μm)	Pith/Hollow Area (μm^2)	No. of Vascular Bundles Per plant	Xylem Thickness (μm)	Phloem Thickness (μm)	Vascular Bundle Area (μm^2)
T0	2202.03 a	9.5264 ab	14.878 b	20.426 ab	1004.26 a	14.17 ab	35.862 ab	9.552 ab	181.86 ab
T1	3034.44 a	10.9274 a	12.104 b	18.493 ab	1195.09 a	13.00 b	40.573 a	7.396 b	212.60 a
T2	3333.33 a	8.5739 abc	14.96 b	18.493 ab	1617.40 a	15.00 a	28.579 c	5.548 b	110.49 c
T3	2719.26 a	7.509 bc	14.234 b	20.846 ab	1082.22 a	13.50 ab	30.821 bc	6.052 b	183.29 ab
T4	3507.77 a	6.1644 c	14.12 b	14.122 b	1842.96 a	13.33 ab	26.562 c	6.388 b	155.07 abc
T5	2563.69 a	7.2851 bc	21.07 a	17.036 ab	1172.78 a	14.50 ab	28.915 c	9.885 ab	150.32 abc
T6	2339.55 a	8.0698 bc	15.635 b	22.191 a	1015.55 a	13.89 ab	31.269 bc	12.54 a	142.23 bc

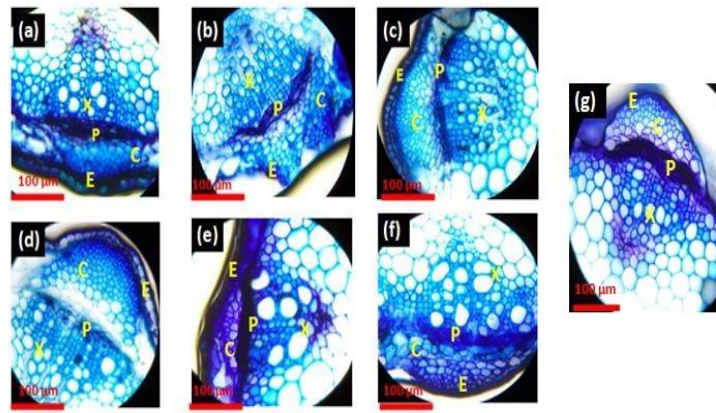


Fig 5 *P. sativum* stem cross sections at 40x, (a) T0, (b) T1, (c) T2, (d) T3, (e) T4, (f) T5, (g) T6, E= Epidermis, C= Cortex, P= Phloem, X= Xylem

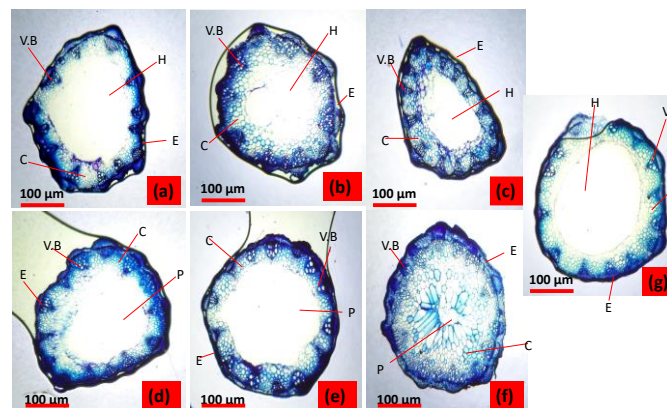


Fig 6: *P. sativum* stem cross sections at 4x, (a) T0, (b) T1, (c) T2, (d) T3, (e) T4, (f) T5, (g) T6, H= Hollow area, C= Cortex, P= Pith, V.B= Vascular bundles

Conclusion

The investigation showed that pruning had selective effects on growth and yield of *Pisum sativum* L. Treatment T3 with two lateral branches recorded highest growth and seed yield, concluding that to improve or maintain productivity, a certain level of branching should be present. The results showed that pruning affects yield components such as number of pods and seeds per plant, increasing our knowledge about how mechanical stresses in plants can be used to improve yield and tolerance in crops. The pruning treatments had no significant impact on the anatomical

features of *P. sativum*. Because little is known about the long-term impacts of pruning on ecophysiological responses of different cultivars, additional studies are needed to assess the effects of different types of pesticides on crown size and yield in pruned plants, which may allow for improved cultivation strategies for *Pisum sativum* L. and related crops over time.

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