

RESEARCH PAPER

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Agronomic performance of the newly pruned coffee trees at the CSU Lal-lo old coffee plantation

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ABSTRACT

Pruning is a strategy employed in many areas to rejuvenate coffee plants and increase berry production. The study was conducted at Cagayan State University, Lal-lo, Philippines, from May, 2021 to June, 2023, focused on rejuvenating old coffee trees through full stumping method for sustainable production. The study evaluated the agronomic performance of newly pruned coffee trees which includes plant height, leaf length, number of leaves, stem girth and Leaf Area Index (LAI). A Randomized Complete Block Design and five treatments was employed across five hectares of newly pruned coffee trees, with 20 sample trees per hectare and three blocks. Treatments included: T₁-all epicormic shoots permitted to grow, T₂-two robust epicormic shoots retained at 1.5 m, T₃-four robust epicormic shoots retained at 1.5 m, T₄-two robust epicormic shoots grown to maximum height and T₅-four robust epicormic shoots grown to maximum height. Insignificant differences were observed in plant height at 30 days after pruning (DAP), number of leaves at 30–90 DAP, stem girth at 30–150 DAP, and LAI at 30 DAP. However, significant results were noted in plant height at 60–150 DAP, number of leaves at 120–150 DAP, leaf length at 30–150 DAP, and LAI at 60–150 DAP. Treatment T₄ achieved the best results in plant height, leaf number, stem girth, leaf length, and LAI, comparable to T₁. The study recommends adopting T₄ for optimal growth and suggests to conduct same study on yield performance of the newly pruned coffee trees and further trials during the dry season for more conclusive findings.

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INTRODUCTION

The CSU-Lal-lo campus has a total land holding of more or less 785 hectares based from the latest land relocation survey of the Department of Environment and Natural Resources (DENR). The greater portion of the lot is utilized for poultry and livestock production, production of various annual crops such as cereals, legumes and high-value vegetable commercial crops (HVCC); and some for plantation crops like mango, coconut, cacao, coffee and other perennials.

Despite this, land utilization in the campus has never been maximized due to insufficient fund. It has an existing 11.4 hectares coffee plantation at the Valena-Villa Verde site, a total of 3,801 coffee trees and 3,338 of them are approximately 55-60 years old and unproductive and the plantation was most likely become forest because of grasses, forest trees, wild vine plants, and bamboo in between the coffee trees.

Thus, rejuvenation or rehabilitation of the area which include pruning is necessary to make the coffee trees become productive again.

On the other hand, pruning is a strategy employed in many areas to rejuvenate coffee plants and increase berry production, however the impact on Coffee Berry Borer infestations varies pivot on the method utilized. For example, in Colombia, it is usual practice to prune, known as "zoqueo," every 5 or 6 years, but the harvest is unreal in the first year, and it repeat some other year or two to restore to regular productivity (Aristizábal *et al.*, 2016).

Pruning can control size of the canopy to make harvesting easier, encourage yield growth, protect against drought and disease, and ultimately improve yields. Coffee berries usually grow only on new branches. As coffee plants age, growth slow units with more branches. The components that each fruited become fibrous and obstruct the light. As a result, the plant becomes less and less productive as it ages. Pruning encourages new growth, reduces self-shading, and thus increases productivity.

Moreover, poor agricultural techniques, including fertilization and tree pruning, contribute to low coffee productivity (1139 kg/ha/year) compared to Aceh province (1568 kg/ha/year) (Saragih, 2013). Taking care of a coffee plantation is difficult work that does not finish with harvest. After the last coffee cherries have been plucked, you may choose to focus on pruning and stumping. These crop management practices can help keep trees healthy and increase productivity. In general, pruning can be done once a year to keep your trees in the appropriate form, improve fruit output, allow air circulation and sunlight penetration, and prevent malnutrition. Remove any unproductive, damaged, diseased, or superfluous branches and leaves using clean, angled cuts. Hence, this study was proposed to rejuvenate and prune the old coffee trees using full stamping method at CSU Lal-lo old coffee plantation for sustainable coffee production.

METHODOLOGY

Securing supplies and materials

The tools, supplies, materials and PPEs used in the study was purchased from a reliable dealer in the province.

Attending trainer's training on coffee production and processing

To have better knowledge and skills on coffee production and processing, the researchers went to Cavite State University Indang Campus to attend the training of trainers before they proceed to the establishment of the study.

Under brushing and cleaning around the coffee trees

Since the area became forest, under brushing and cleaning around the coffee trees was done prior to the conduct of the other activities.

Pruning the old coffee trees using full stamping technique

Pruning using Stumping technique was done to remove the large portion of the trunk of the coffee trees. This was done using a chain saw or pruning

saw through cutting the old stems from 40 cm to the ground level. Hence, pruning was done because of the drastically decline on the growth as well as production of the old trees, to make more space and allow sunlight on the photosynthetic activity of coffee plants.

Marking, staking and lay-outing of the newly pruned coffee trees

The newly pruned coffee trees was marked. After which, the experiment was established using Randomized Complete Block Design and an space of 4mx4m. A randomly 20 sample trees per hectare was selected and stake was placed to the sample plants then tagging was done after for better identification.

The treatment used were as follows: Treatment 1- all epicormic shoots permitted to grow, Treatment 2- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; Treatment 3- four robust epicormic shoots retained at 1.5 m height; Treatment 4- two robust epicormic shoots grown to maximum height; and Treatment 5- four robust epicormic shoots grown to maximum height.

Care and maintenance of the crops

Fertilizer was applied based from the recommended rate of the soil analysis.

A program for effective control of pests and diseases was carried out. The metharhizium was sprayed early in the morning and late in the afternoon. This was applied upon damage of insects on leaves.

Data gathered

The data was gathered using the following parameters: a) Plant Height (cm). A 20 sample plants was measured using a meter stick from the base up to the tip of the seedlings. This was gathered from 30, 60, 90, 120 to 150 days after pruning. b) Number of leaves developed (#). This was determined by counting the total leaves of the 20 sample plants produced in every month until 5 months of its operation. c) Length of leaves (cm). This was determined by measuring the leaves from the base to

the tip of the 20 samples plants. This was gathered from 30, 60, 90, 120 to 150 days after pruning. d) Stem girth (\emptyset).

This was obtained by measuring the diameter of the shoots or stem of the 20 sample plants using a vernier caliper or tape measure after which, this was counted and recorded. This was gathered from 30, 60, 90, 120 to 150 days after pruning. e) Leaf area Index (LAI). This was obtained by measuring the four (4) leaves per sample plant in a treatment from top to bottom of the leaves using a graphing paper.

Analyzing the data

The collected data was analyzed through the Analysis of Variance (ANOVA) of Randomized Complete Block Design (RCBD) under STAR software.

RESULTS AND DISCUSSION

Plant height of the newly pruned coffee trees for five months of operation

Table 1 displays the plant height of newly pruned coffee plants maintained and managed utilizing various epicormic shoots from 30, 60, 90, 120, to 150 Days After Pruning (DAP).

Insignificant result was obtained to the newly pruned coffee trees at 30 Days After Pruning (DAP). However, result revealed that the tallest plant height was obtained in T₄- two robust epicormic shoots grown to maximum height with a mean of 21.20 cm, followed by plants in T₁- all epicormic shoots permitted to grow with a mean of 20.81 cm and 51.34 (cm), T₃- four robust epicormic shoots retained at 1.5 m height with a mean of 20.21 cm, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height with a mean of 19.98 cm, and the least was found in T₅- four robust epicormic shoots grown to maximum height with a mean of 19.96 cm.

However, plant height of newly pruned coffee trees from 60, 90, 120 to 150 DAP revealed significant results. Thus, T₄- two robust epicormic shoots grown to maximum height and T₁- all epicormic shoots

permitted to grow had a comparable results, but they were also comparable to T₃- four robust epicormic shoots retained at 1.5 m height, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height and T₅- four

robust epicormic shoots grown to maximum height, where in results shows that T₅- four robust epicormic shoots grown to maximum height obtained the lowest height of the plants in the five (5) months operation of the study.

Table 1. Plant height (cm) of the newly pruned coffee trees using stumping method for five (5) months of operation

Treatment	Plant height (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T ₁	20.81	52.39 _a	73.59 _a	96.32 _a	125.12 _a
T ₂	19.98	49.50 _b	70.44 _b	91.46 _c	122.89 _b
T ₃	20.21	50.26 _b	71.98 _b	93.00 _b	123.78 _b
T ₄	21.20	52.65 _a	73.82 _a	96.34 _a	125.46 _a
T ₅	19.96	48.89 _b	67.79 _c	90.90 _c	119.16 _c
	ns	*	*	*	*

T₁- all epicormic shoots permitted to grow, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; T₃- four robust epicormic shoots retained at 1.5 m height; T₄- two robust epicormic shoots grown to maximum height; and T₅- four robust epicormic shoots grown to maximum height.

*=significant at 5%, ns= non-significant.

Table 2. Number of developed leaves of the newly pruned coffee trees for five (5) months of operation

Treatment	Number of developed leaves				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T ₁	6.59	9.14	12.18	15.00 _a	18.66 _a
T ₂	5.37	8.96	10.8	13.42 _b	15.55 _b
T ₃	5.90	8.98	11.95	12.45 _b	16.28 _b
T ₄	6.86	9.69	12.89	15.14 _a	18.99 _a
T ₅	5.17	8.79	10.68	12.13 _b	15.49 _b
	ns	ns	ns	*	*

T₁- all epicormic shoots permitted to grow, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; T₃- four robust epicormic shoots retained at 1.5 m height; T₄- two robust epicormic shoots grown to maximum height; and T₅- four robust epicormic shoots grown to maximum height.

*=significant at 5%, ns= non-significant.

Thus, Analysis of Variance shows significant results from 60, 90, 120 to 150 DAP which simply means that the epicormic shoots maintained and manage to the newly pruned coffee trees had a significant effect to its growth and development.

The significant result of this study shows that the interaction of pruning with plant growth regulators also positively influenced plant height and productivity. Thus, the significant results of plant height in newly pruned coffee trees indicate that pruning can have a profound impact on growth and productivity. Research shows that optimal pruning heights can enhance vegetative growth, flowering, and ultimately yield (Muliasari *et al.*, 2021).

Number of developed leaves for six months

Table 2 shows the number of developed leaves of the newly pruned coffee trees from 30, 60, 90, 120 to 150 days after pruning. Insignificant results was obtained at 30, 60 and days after pruning with a mean ranging from 5.17 to 12.89.

However, significant results was garnered on the number of developed leaves at 120 and 150 days after pruning of the newly pruned coffee trees. It showed that T₄- two robust epicormic shoots grown to maximum height obtained the most number of developed leaves with a mean of 15.14 and 18.99, respectively. It was followed by T₁- all epicormic shoots permitted to grow with a mean of 15.00 and

18.66. T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height with a mean of 14.42 and 15.55, T₃- four vigorous epicormic shoots retained at 1.5 m height with a mean of 12.45 and 16.28, and the least was found in T₅- four vigorous epicormic shoots grown to maximum height with a mean of 12.13 and 15.49.

This study's substantial results found out that Robusta coffee (*C. canephora*) effect the gas exchange in the leaves and carbon absorbed by coffee plants. (Fahl *et al.*, 2001)

Stem girth of the newly coffee pruned coffee trees for five months of operation

Table 3 shows the stem girth of the newly pruned coffee trees maintained and managed from 30, 60, 90, 120 to 150 Days after Pruning. Results disclosed that the widest stem girth of newly pruned coffee trees were obtained in T₄- two robust epicormic shoots grown to

maximum height with a mean of 0.59 Ø, 0.95 Ø, 1.87 Ø, 2.69 Ø and 3.43 Ø, respectively.

This was followed by T₁- all epicormic shoots permitted to grow with a mean of 0.56 Ø, 0.91 Ø, 1.79 Ø, 2.46 Ø and 3.38 Ø, T₃- four robust epicormic shoots retained at 1.5 m height with a mean of 0.40 Ø, 0.89 Ø, 1.40 Ø, 2.38 Ø and 3.22 Ø, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height with a mean of 0.39 Ø, 0.87 Ø, 1.52 Ø, 2.41 Ø and 3.25 Ø, and the least was found in T₅- four robust epicormic shoots grown to maximum height with a mean of 0.26 Ø, 0.80 Ø, 1.29 Ø, 2.28 Ø and 3.10 Ø, respectively.

However, there were no significant numerical changes among treatments for this parameter, as evidenced by the Analysis of Variance (ANOVA). This simply suggests that whatever treatments were utilized in the study can alter the stem girth of newly pruned coffee trees.

Table 3. Stem girth (Ø) of the newly pruned coffee trees for five months of operation

Treatment	Stem girth (Ø)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T ₁	0.56	0.91	1.79	2.46	3.38
T ₂	0.39	0.87	1.52	2.41	3.25
T ₃	0.40	0.89	1.40	2.38	3.22
T ₄	0.59	0.95	1.87	2.69	3.43
T ₅	0.26	0.80	1.29	2.28	3.10
	ns	ns	ns	ns	ns

T₁- all epicormic shoots permitted to grow, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; T₃- four robust epicormic shoots retained at 1.5 m height; T₄- two robust epicormic shoots grown to maximum height; and T₅- four robust epicormic shoots grown to maximum height.

ns= non-significant.

Length of leaves of the newly pruned coffee trees for 5 months of operation

The length of leaves of the newly pruned coffee trees maintained and managed from 30, 60, 90, 120 to 150 days after pruning is presented in Table 4. Significant result was obtained on the length of leaves from 30, 60, 90, 120 to 150 days after pruning, where in T₄- two robust epicormic shoots grown to maximum height obtained the longest length of leaves with a mean of 13.20 cm, 17.60 cm, 22.00 cm, 27.42 cm, and 31.92, respectively. But the latter had a comparable effect to T₁- all

epicormic shoots permitted to grow with a mean of 12.42 cm, 16.93 cm, 21.44 cm, 26.35 cm and 30.48 cm. On the other hand, T₃- four robust epicormic shoots retained at 1.5 m height with a mean of 10.48 cm, 15.43 cm, 20.38 cm, 21.31 cm, and 25.86 cm is also comparable to T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height and T₅- four robust epicormic shoots grown to maximum height with a mean of 9.93 cm and 9.54 cm, 14.85 cm and 13.05 cm, 19.77 cm and 19.56 cm, 23.22 cm and 21.12 cm, and 27.65 cm and 25.30 cm, respectively.

Table 4. Length of leaves (cm) of the newly pruned coffee trees for five months of operation.

Treatment	Length of leaves (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T ₁	12.42 _a	16.93 _a	21.44 _b	26.35 _a	30.48 _a
T ₂	9.93 _c	14.85 _b	19.77 _c	23.22 _b	27.65 _b
T ₃	10.48 _b	15.43 _b	20.38 _{bc}	21.31 _c	25.86 _c
T ₄	13.20 _a	17.60 _a	22.00 _a	27.42 _a	31.92 _a
T ₅	9.54 _c	13.05 _c	19.56 _c	21.12 _c	25.30 _c
	*	*	*	*	*

T₁- all epicormic shoots permitted to grow, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; T₃- four robust epicormic shoots retained at 1.5 m height; T₄- two robust epicormic shoots grown to maximum height; and T₅- four robust epicormic shoots grown to maximum height.

*=significant at 5%.

Table 5. Leaf area index (LAI) of newly pruned coffee trees for five months of operation

Treatment	Leaf area index				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T ₁	5.90	8.94 _b	10.97 _b	13.56 _{1a}	16.71 _b
T ₂	5.87	7.88 _c	9.22 _c	12.50 _c	15.85 _c
T ₃	5.81	8.18 _b	10.93 _b	13.18 _b	16.62 _b
T ₄	5.99	9.98 _a	11.39 _a	14.10 _a	17.00 _a
T ₅	5.62	7.70 _c	8.78 _c	11.97 _c	14.76 _c
	ns	*	*	*	*

T₁-all epicormic shoots permitted to grow, T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height; T₃- four robust epicormic shoots retained at 1.5 m height; T₄- two robust epicormic shoots grown to maximum height; and T₅- four robust epicormic shoots grown to maximum height.

*=significant at 5%, ns= non-significant.

The study's noteworthy findings on the length of leaves on newly pruned coffee trees reveals various insights into the results of pruning on coffee plant growth and productivity, where in pruning when combined with specific fertilization techniques, can influence growth parameters such as stem diameter and new shoot length (Rohani *et al.*, 2024).

Leaf area index (LAI) of newly pruned coffee trees for five months of operation

The Leaf Area Index of the newly pruned coffee trees from 30, 60, 90, 120 to 150 days after pruning is presented in Table 5. Insignificant result was obtained on the leaf area index at 30 days after planting with mean values ranging from 5.62 cm to 5.99 cm.

The LAI from 60, 90, 120 to 150 days after pruning display an evident results as maintained and managed using the different epicormic shoots. Results revealed that T₄- two robust epicormic shoots grown to maximum height obtained the highest Leaf

Area Index with a mean of 9.98 cm, 11.39 cm, 13.81 and 16.62 cm, respectively.

This was followed by T₁- all epicormic shoots permitted to grow with a mean of 8.94 cm, 10.97 cm, 13.56 cm and 16.71 cm. However, the latter had a comparable effects to T₃- four robust epicormic shoots retained at 1.5 m height with a mean of 8.18 cm, 10.93 cm, 13.18 cm and 16.62 cm, respectively. Thus, these two (2) treatments were comparable to T₂- two robust epicormic shoots permitted to grow and retained at approximately 1.5 m height with a mean of 7.88 cm, 9.22 cm, 12.50 cm, and 15.85 cm and T₅- four robust epicormic shoots grown to maximum height with a mean of 7.70 cm, 8.78cm, 11.97 cm and 14.76 cm, respectively.

Overall, T₄- two robust epicormic shoots grown to maximum height, resulting in the largest leaf area. The findings of the study shows that larger leaf area increases the photosynthetic capacity in plants. Furthermore, the Leaf Area Index indicates how

much light passes through the coffee plant canopy (Niklas and Cobb, 2007; Li *et al.*, 2019).

CONCLUSION

Based on the study's findings, it was determined that all of the treatments utilized in the study are appropriate for newly pruned coffee trees for a period of five months. The study found that T₄- two robust epicormic shoots grown to maximum height resulted in the tallest plant height, most developed leaves, widest stem girth, longest leaf length, and longest Leaf Area Index (LAI). However, T₁- allowing all epicormic shoots to grow produced comparable results in some parameters. This simply indicates that the two treatments utilized in the study had identical effects on the growth and development of newly pruned coffee trees.

Based on the findings of the study, T₄- two robust epicormic shoots grown to maximum height is highly recommended because it obtained the tallest plant height, produced more number of leaves, widest stem girth, longest length of leaves and Leaf Area Index (LAI). Further trials and yield performance are needed to provide more conclusive results.

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