Responses of different levels of pruning and biofertilizer on fruit growth and quality of Assam lemon [*Citrus limon* (L.) Burm] under the foothills of Arunachal Pradesh

ABSTRACT:

The present experiment was conducted in the Department of Fruit Crops, College of Horticulture and Forestry, Pasighat, Arunachal Pradesh, during the year 2021-2022. The trial was laid out using two factorial RBD replicated thrice. Assam lemon trees were pruned at 25% (P_1), 50% (P_2) from the top apex and soil drenching with *Pseudomonas fluorescens* @ 90g/plant (B_1), Trichoderma @ 90g/plant (B_2), Azotobacter @ 15g/plant (B_3) and a combination of PGPR (*Pseudomonas fluorescens*) @ 90g/plant + Trichoderma @ 90g/plant + Azotobacter @ 15g/plant (B_4) at two feet away from the tree trunk with the interaction of both factors and were compared with control. The results revealed that the morphological and biochemical characters were significantly affected by high pruning intensity (50%) and biofertilizers treatment B_4 (*Pseudomonas fluorescens* @ 90g/plant + Trichoderma @ 90g/plant + Azotobacter @ 15g/plant) and their combinations. It was concluded that the treatment P_2B_4 pruning 50% (from the apex) + *Pseudomonas fluorescens* @ 90g/plant + Trichoderma @ 90g/plant + Azotobacter @ 15g/plant in Assam lemon were vital for fruit morphological and biochemical characteristics.

Keywords: Pruning intensity, fruit growth, quality and biofertilizers

INTRODUCTION

Citrus (*Citrus sp.*) one the world's primary fruit crops grown in many tropical and subtropical nations. It is a member of the Rutaceae family, which has 140 genera and 1300 species (Ghosh *et al* 2016) The lemon fruit's main distinguishing qualities are its oval to elliptical form, intensely aromatic rind, and strong acidity levels. It is in high demand in both the domestic and foreign markets due to its distinctive aroma, vitamin C, titratable acidity, carotenoids, folate, fiber, zero fat, and high concentration of natural antioxidants. Assam lemon is a significant dwarf cultivar of lemon that is appropriate for high-density planting and is widely grown in north-eastern India. It bears early in northern West Bengal and southern Arunachal Pradesh, with three fruiting seasons: April-May, August-September, and November-December. Early vegetative flushes of previous season growth are often more productive. So pruning is very much essential to manipulate various aspects of fruiting and quality. Pruning branches is a cultural strategy that enhances fruit morphology and

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quality responses. Shoot trimming has a significant impact on tree development and photosynthesis because it changes the design of the aerial sections. Fruits normally grow faster in pruned trees, and depending on growth conditions, an equilibrium between shoots and roots can be achieved. Because lemon trees bear three times a year, correct manuring and fertilising must be used to achieve the best yields and quality production, which is dependent on healthy and vigorous tree growth. Furthermore, in addition to the traditional application of chemical fertilisers, a combination of bio-fertilizers must be used to avoid the negative effects of chemical fertilisers while also improving soil physical properties by increasing nutrient and water holding capacity, total pore space, aggregate stability, erosion resistance, and temperature insulation. However, nothing is known about the response of lemons to pruning and nutrient management in this area. Keeping this in mind, the current inquiry was carried out to investigate the effect of different levels of pruning and biofertilizers on fruit growth and quality parameters of Assam lemon [C*itrus limon* (L.) Burm] under the foothills of Arunachal Pradesh.

MATERIALS AND METHODS

The current study was conducted on a seven-year-old Assam lemon orchard at the Citrus Fruit Block, College of Horticulture and Forestry, Pasighat, Arunachal Pradesh, India, from 2021 to 2022. The orchard is geographically located at 28° 04' 43" N latitude and 95° 19′26″E longitude, with an altitude of 153 m above mean sea level. The experiment was set up using two Factorial Randomized Block Designs (FRBD) and 15 treatment combinations (three levels of pruning and five levels of biofertilizers), each with three replications. PGPR (*Pseudomonas fluorescens*) @ 90g/plant (B_1), Trichoderma @ 90g/plant (B_2), Azotobacter @ 15g/plant (B_3), and a combination of PGPR (*Pseudomonas fluorescens*) @ 90g/plant + Trichoderma @ 90g/plant + Azotobacter @ 15g/plant (B_4) were applied alone and in combination with different levels of pruning. Pruning practices were performed in February 2021, and biofertilizers were applied to the soil two feet away from the tree stem at the same time. During the experiment, crop management measures such as irrigation, weeding, and other cultural treatments were carried out at regular intervals. Data on fruit morphology, yield, and quality were collected from three labeled plants for each treatment. There were total 45 treatment trees. The following observations were recorded…

Fruit length (mm): After harvest, the fruit length was measured from blossom end to stem end with a digital Vernier caliper. The average length of the fruit was then expressed in millimeters (mm).

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Fruit width (mm): The width of the fruits was measured using a digital Vernier caliper in the center of four representative fruit samples from each plant and expressed millimetres (mm).

Fruit volume (cm^3): The volume of the fruit was measured using the water displacement method and represented in cubic centimeters (cm^3). The fruits were chosen at random from each treatment.

Fruit weight (g): Four fruits were chosen at random and their weights were recorded using a precision weighing scale. The average weight of the fruits was stated in grams (g).

Peel weight (g): After peeling with a knife, the peel weight of a randomly selected representative fruit sample (four in number) from each treatment was recorded using an accurate weighing balance. The average fruit weight was given in grams (g).

Number of seeds per fruit: The number of seeds per fruit was manually counted after extracting seeds from fully matured fruits separately from four randomly selected fruits, and the average was derived by dividing the total number of seeds by the total number of fruits. It is given as the number of seeds per fruit.

Total soluble solids (°Brix): The fruit's TSS was tested using a hand-held refractometer (0 ^{o}B-32 ^{o}B). The reading was taken through the eyepiece after a little drop of fruit juice was deposited on the prism surface.

Titratable acidity (%): The fruit's titratable acidity was assessed by titrating the fruit juice against 0.1N NaOH solution using phenolphthalein as an indicator (light pink endpoint) and stated as a percentage in terms of citric acid (AOAC, 2002).

Titratable acidity (%) = Titre reading x Normality of alkali x Equivalent weight of acid x 100/Volume of the sample taken ×100.

$$\text{Titratabidity (\%)} = \frac{\text{Titre reading x Normality of alkali x Equivalent weight of acid x 100}}{\text{Volume of the sample taken } \times 100}$$

Vitamin C content (mg/100 g): Ascorbic acid estimation was carried out by the Spectrophotometer method as described by Jagota and Dani (1982).

Juice content (ml): Juice was extracted from four randomly selected fruits and was measured in a measuring cylinder. The average juice content per fruit was then expressed in milliliters (ml).

Total sugars (%): Total sugar content was estimated by the Anthrone method as described by Hedge and Hofreiter (1962).

Reducing sugar (%): Reducing sugar content was estimated by the Spectrophotometric method as described by Somogyi (1952).

Statistical analysis: The statistical analysis of two-factorial RBD were done using (the Microsoft excel). Calculating the corresponding 'F' values as reported by Gomez and Gomez (2010). determined the significance and non-significant of the variation due to the different treatments.

RESULTS AND DISCUSSION

Fruit length (mm)

The results depicted in table 1made it clear that the fruit length had significantly increased over the applied pruning levels. P_0 (unpruned) had the least fruit length (78.23 mm), whereas P_2 (50% pruning) had the largest (85.98 mm). Similar to this, biofertilizer strains dramatically lengthen fruit, with treatment B_4 (PGPR + Trichoderma + Azotobacter) having the longest fruit (89.54 mm) and treatment B_0 (no-biofertilizer) having the shortest (76.52 mm). The interaction of factors significantly improved fruit length; the treatment combination P_2B_4 (Pruning 50% length of shoot + PGPR + Trichoderma + Azotobacter) had the longest fruit length (90.72 mm), while P_0B_0 (control) had the shortest (69.33 mm).

These results may be explained by the longer fruit length in citrus plants that had undergone significant pruning compared to unpruned plants, which was caused by improved sunlight penetration in the plant canopy (Singh *et al.*, 2004). Similar to this, larger fruit size in heavily pruned plants may be attributed to lower fruit density and an increase in the leaf-to-fruit ratio, which provided higher photosynthates to the plants under this treatment; however, lower fruit size in unpruned plants may be caused by higher photo assimilate competition among developing fruits (Singh *et al.*, 2012). Similar results were discovered by Ghosh (2015) when pruning and biofertilizers were combined, and it was noted that the pruning increased nutrient availability and the production of photosynthates, which led to an increase in fruit weight, volume, and peel thickness.

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Fruit width (mm)

Fruit width (Table 1) was shown to be substantially and significantly influenced by pruning levels. P_0 had the smallest (46.32 mm) fruit width, whereas P_2 had the largest fruit width (53.70 mm). Similarly, biofertilizer levels had a substantial impact on fruit width as well, with treatment B_4 having the highest maximum (56.81 mm) and treatment B_0 having the lowest (42.88 mm). Additionally, there was a significant interaction between pruning and biofertilizers, with a maximum effect of (59.85 mm) in treatment combination P_2B_4 and a minimum of (39.82 mm) effect in treatment combination P_0B_0 (control).

Lower fruit density and a higher leaf-to-fruit ratio, which provided more photosynthates to the plants under this treatment, may be responsible for the heavily pruned plants' larger fruit sizes; in contrast, higher photo assimilate competition among developing fruits may be the cause of unpruned plants' smaller fruit sizes (Singh *et al.*, 2012). Shamseldin *et al.*, (2010) also noted that Washington navel orange fruit quality and length were increased by biofertilizer inoculation with *Pseudomonas fluorescence* strain 843 growth-promoting rhizobacteria.

Fruit weight (g)

It has been demonstrated (Table 1) that pruning levels have a significant effect on fruit weight. P_0 had the lightest fruit weight (84.30 g), whereas P_2 had the heaviest fruit (94.54 g). The weight of the fruit is also significantly influenced by biofertilizer levels, with treatment B_4 having the highest level (100.33 g) and treatment B_0 having the lowest level (83.86 g). Also increasing fruit weight throughout treatments was recorded in the interaction of pruning and biofertilizers, with the maximum value (103.67 g) recorded in treatment combination P_2B_4 and the lowest value (78.61 g) reached in P_0B_0 (control). These results might be due to the more sunlight penetration in the plant canopy, which led to greater fruit weight and color development in citrus plants that had been heavily pruned as opposed to unpruned plants. Increased cell division, cell elongation, fruit weight, enhanced root development, and improved water absorption and nutrient deposition transfer are all factors that can improve fruit quality, as can hormone induction and appropriate nutrient delivery (Ghosh, 2015). This could be connected to more effective fertilizer application when using organic nutrition (Lal and Dayal, 2014).

Fruit volume (cm^3)

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The amounts of pruning significantly affected fruit volume (Table 1). The fruit volume of P_2 was maximum (69.01 cm^3), whereas P_0 was minimum (56.01 cm^3). Similar results were reported for the biofertilizer levels on fruit volume, with B_4 having the highest level (78.29 cm^3) and B_0 having the lowest level (54.33 cm^3). Additionally, there was a significant interaction between pruning and biofertilizers, with a maximum impact of P^2B^4 (83.92 cm^3) and a minimum (45.51 cm^3) of P_0B_0.

It might be a result of the pruning increasing nutrient availability and the production of photosynthates, leading to bigger fruits and a higher fruit volume. The increased photophosphorylation and the dark reaction of photosynthesis, which result in the accumulation of more carbohydrates and also enhance the translocation of photosynthates, which mobilize the stored material from the leaves and stem towards the fruit, may be the cause of the increased fruit volume with the nutrient application, which is increased by biofertilizers through nutrient mobilization (Sandhu and Bal, 2012).

Peel weight (g)

Table 1 illustrated that pruning levels had a significant influence on peel weight. The peel weight of P_2 was the highest (40.22 g), while the peel weight of P_0 was the lowest (34.39 g). Similarly, the biofertilizer levels had a substantial impact on peel weight, with treatment B_4 having the maximum (43.78 g) and B_1 having minimum (34.64 g). Additionally, the interaction of two components increased peel weight throughout treatments, with the maximum value (44.88 g) recorded in treatment combination P_2B_4 and equalling (44.08 g) to P_1B_4, and the lowest value (28.93 g) recorded in P_0B_1. The results of Ghosh (2015) concur with our findings, which showed that pruning increased the number of nutrients available and the production of photosynthates, leading to an increase in fruit weight, volume and peel thickness.

Number of seeds per fruit

It has been demonstrated (Table 1) that pruning levels considerably impact the typical number of seeds per fruit. P_2 had the most seeds per fruit on average (0.16), whereas P_0 had the fewest seeds per fruit on average (0.03). Similar to this, biofertilizer levels had a substantial impact on the number of seeds per fruit, with the highest level (0.22) in treatment B_4 and the lowest level (0.03) in treatments B_1 (PGPR) and B_2 (PGPR + Trichoderma). The average number of seeds per fruit also increased as a result of the interaction of two factors, with treatment combination P_2B_4 recording the highest value (0.25) and P_0B_0, P_0B_1, and P_0B_2 acquiring the lowest value(0.00), respectively. The presence of less and more number of seeds in a fruits may be due to the availability of nutrient sources as well the absorption of more amount of nutrients in highly pruned branches in faster rate.

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Table 1: Effects of pruning severity and biofertilizers on fruit growth parameters of Assam lemon

Treatments	Fruit length (mm)	Fruit width (mm)	Fruit weight (g)	Fruits volume (cm^3)	Peel weight (g)	Number of seeds/fruit
(A) Effect of Pruning Severity						
P_0	78.23	46.32	84.30	56.01	34.39	0.03
P_1	83.26	47.40	90.59	63.27	38.28	0.06
P_2	85.98	53.70	94.54	69.01	40.22	0.16
S.Em ±	0.085	0.059	0.060	0.073	0.058	0.000
C.D. 0.05%	0.246	0.171	0.174	0.211	0.167	0.001
(B) Effect of Biofertilizers						
B_0	76.52	42.88	83.86	54.33	35.21	0.08
B_1	80.04	45.49	87.03	57.61	34.64	0.03
B_2	82.78	49.60	88.74	60.27	36.99	0.03
B_3	83.57	50.93	89.08	63.32	37.54	0.08
B_4	89.54	56.81	100.33	78.29	43.78	0.22
S.Em ±	0.142	0.099	0.100	0.121	0.096	0.000
C.D. 0.05%	0.410	0.286	0.291	0.351	0.278	0.001
Effect of (AXB) Interaction						
P_0B_0	69.33	39.82	78.61	45.51	33.03	0.00
P_0B_1	74.88	43.96	81.94	50.57	28.93	0.00
P_0B_2	78.86	45.04	82.23	54.58	33.66	0.00
P_0B_3	79.24	47.77	82.78	56.05	33.97	0.00
P_0B_4	88.83	55.00	95.95	73.33	42.37	0.17
P_1B_0	79.78	40.40	85.22	57.92	35.28	0.00
P_1B_1	80.44	40.41	87.55	58.75	35.68	0.00
P_1B_2	82.88	49.92	89.33	59.90	37.77	0.00
P_1B_3	84.13	50.69	89.46	62.17	38.57	0.08
P_1B_4	89.06	55.59	101.37	77.63	44.08	0.23
P_2B_0	80.44	48.41	87.76	59.56	37.33	0.24
P_2B_1	84.81	52.09	91.67	63.50	39.30	0.08
P_2B_2	86.60	53.84	94.65	66.33	39.53	0.08
P_2B_3	87.33	54.32	95.01	71.75	40.08	0.17
P_2B_4	90.72	59.85	103.67	83.92	44.88	0.25
S.Em ±	0.425	0.296	0.301	0.364	0.288	0.001
C.D. 0.05%	1.231	0.857	0.872	1.054	0.835	0.003

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Total soluble solids (°Brix)

When compared to all other pruning treatments, the severity of pruning had a significant influence on TSS content (Table 2). TSS was highest (5.40 °Brix) in the treatment that pruned 50% of the length of the shoots (P_2) and lowest (5.22 °Brix) in the un-pruned (P_0). Similarly, differing biofertilizer levels had a significant influence on TSS, with treatment B_4 (PGPR + Trichoderma + Azotobacter) having the greatest (5.51 °Brix) and treatment B_0 (No-biofertilizers) having the lowest (5.19 °Brix). The interaction between pruning severity and biofertilizer levels, on the other hand, was found to be non-significant. The increase in total soluble solids content in fruits could be ascribed to improved nutrient availability and hormone induction, which promotes cell division, cell elongation, increased fruit quantity and weight, improved root development, and improved water uptake and nutrient deposition. This could be related to increased fertilizer use efficiency through the use of biological nutrition sources (Lal and Dayal, 2014). Shamseldin *et al.* (2010) discovered a similar result in Washington navel orange and showed that bio-fertilizer inoculation with Pseudomonas fluorescence strain 843 growth-boosting rhizobacteria significantly increased TSS.

Titratable acidity (%)

Pruning had a large and considerable (Table 2) impact on titratable acidity. The treatment (P_2) had the highest (5.71%) titratable acidity while the lowest (4.33%) was recorded P_0. The use of different biofertilizers also shown a significant influence on titratable acidity, with treatment B_4 (PGPR + Trichoderma + Azotobacter) having the greatest (5.89%) and treatment B_0 having the lowest (4.51%). Similarly, the combination of pruning severity and biofertilizer levels increased titratable acidity, with the maximum titratable acidity (5.90%) reported in treatments pruning 50% + PGPR + Trichoderma + Azotobacter (P_2B_4) and Pruning 25% + PGPR + Trichoderma + Azotobacter (P_1B_4). which is comparable to P_2B_2 (5.84%), P_2B_3 (5.85%), and P_0B_4 (5.88%), while treatment control (P_0B_0) had the lowest (3.72%). Pruning and biofertilizer interaction had a considerable effect on titratable acidity. It could be because pruning enhanced the rate of photosynthesis, resulting in higher light penetration into the inner tree canopy, and biofertilizers impact auxin hormones, which function as carbohydrate mobilization from the source of skin (fruits), resulting in increased fruit quality. The higher titratable acidity could be due to the fact that the humic acid and fulvic acid components of organic soil organic matter formed water-soluble micronutrients, enhancing their availability and absorption and resulting in improved quality (Kumar *et al.*, 2012)

Vitamin C content (mg/100 g)

Pruning levels had a considerable (Table 2) impact on vitamin C content. The pruning 50% length of shoots (P_2) treatment had the highest ascorbic acid content (120.37 mg) and the lowest (100.20 mg) in the un-pruned treatment (P_0). Similarly, the use of different doses of biofertilizer had a significant influence on ascorbic acid, with treatment B_4 (PGPR + Trichoderma + Azotobacter) having the greatest ascorbic acid concentration (130.68 mg) and treatment B_0 (no-biofertilizers) having the lowest (100.41 mg). Furthermore, a substantial interaction between pruning severity and biofertilizer levels was discovered. The treatment

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pruning 50% + PGPR + Trichoderma + Azotobacter (P_2B_4) had the maximum concentration of ascorbic acid (141.08 mg), whereas the control (P_0B_0) had the lowest concentration (85.79 mg). The presence of ascorbic acid in fruits can be ascribed to adequate nutrition and hormone stimulation, which promotes cell division, cell elongation, a rise in fruit number and weight, increased root development, and improved water transfer and nutrient deposition. This could be attributed to increased fertilizer efficiency through the use of organic nutrition sources (Lal and Dayal, 2014). Ghosh (2015) discovered similar results and confirmed that high-degree pruning intensity with biofertilizers increases titratable acidity.

Total sugars (%)

Pruning levels improved the total sugar content of Assam lemon fruits considerably (Fig. 1). P_2 had the highest value (8.41%), while P_0 had the lowest value (6.20%). Furthermore, biofertilizer dosages had a significant impact on lemon fruit total sugars, ranging from 6.40% in treatment B_0 to 9.40% in treatment B_4. The interaction between pruning intensity and biofertilizer levels was also shown to be significant, with P_2B_4 having the highest (9.84%) and P_0B_0 having the lowest (4.74%).

It could be because of proper nutrition delivery and growth hormone stimulation, which increased cell division, cell elongation, better translocation of water intake, and nutrient deposition as a result of fertilizer usage efficiency (Yadav *et al.*, 2011). Nanaso (2017) reported a similar result, observing that the greatest total sugar was detected in sweet orange due to biofertilizer inoculation with Azotobacter, PSB, and Trichoderma.

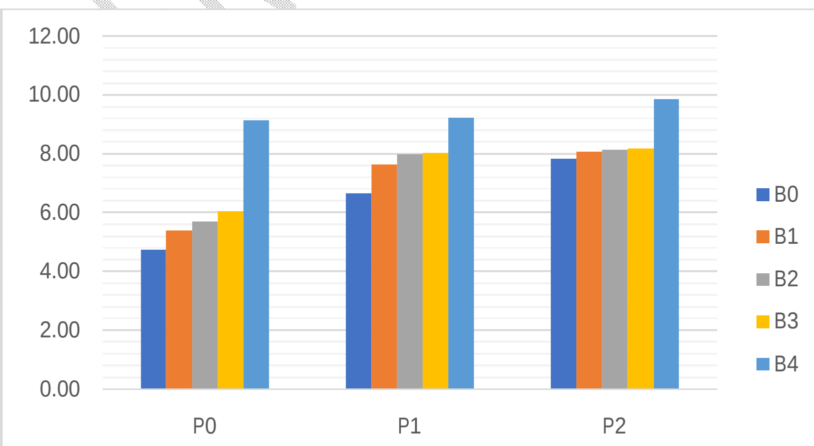

Fig. 1 Effect of pruning and biofertilizers on total sugar content in Assam lemon's fruit

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Table 2: Effects of pruning severity and biofertilizers on biochemical characteristics of Assam lemon fruits.

Treatments	Total soluble solids (°Brix)	Titratable acidity (%)	Vitamin C content (mg/100 g)	Total sugars (%)
(A) Effect of Pruning Severity				
P_0	5.22	4.33	100.20	6.20
P_1	5.32	5.22	112.10	7.90
P_2	5.40	5.71	120.37	8.41
S.Em ±	0.008	0.008	0.107	0.015
C.D. 0.05%	0.025	0.023	0.311	0.043
(B) Effect of Biofertilizers				
B_0	5.19	4.51	100.41	6.40
B_1	5.26	4.84	103.45	7.03
B_2	5.28	5.09	109.08	7.27
B_3	5.32	5.10	110.85	7.42
B_4	5.51	5.89	130.68	9.40
S.Em ±	0.014	0.013	0.179	0.025
C.D. 0.05%	0.041	0.038	0.519	0.071
Effect of (AXB) Interaction				
P_0B_0	5.11	3.72	85.79	4.74
P_0B_1	5.17	3.77	90.88	5.39
P_0B_2	5.18	4.11	98.95	5.70
P_0B_3	5.21	4.15	100.74	6.05
P_0B_4	5.42	5.88	124.66	9.13
P_1B_0	5.22	4.62	105.32	6.65
P_1B_1	5.23	4.97	106.54	7.63
P_1B_2	5.28	5.31	110.87	7.99
P_1B_3	5.36	5.31	111.46	8.03
P_1B_4	5.51	5.90	126.30	9.22
P_2B_0	5.23	5.18	110.11	7.82
P_2B_1	5.37	5.78	112.92	8.07
P_2B_2	5.38	5.84	117.42	8.13
P_2B_3	5.40	5.85	120.34	8.17
P_2B_4	5.61	5.90	141.08	9.84
S.Em ±	N.S.	0.039	0.537	0.074
C.D. 0.05%	N.S.	0.113	1.556	0.213

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Reducing and non-reducing sugar

Pruning levels significantly (Fig. 2 & 3) increased the reducing sugar and non-reducing sugar content, with the maximum value (2.12% and 6.39%) recorded in P_2 and the lowest (1.88% and 4.41%) recorded in P_0. Furthermore, biofertilizer levels altered the reducing sugars and no-reducing sugars of lemon fruits, ranging from (1.82% and 4.68%) in B_0 to (2.18% and 7.33%) in B_4. The interaction between pruning intensity and biofertilizer levels was also shown to be significant, with P_2B_4 having the highest reducing sugar and no-reducing sugar levels (2.20% and 7.75%) and P_0B_0 having the lowest (1.40% and 3.41%). Sugar levels may have increased due to the availability of accessible photosynthates for developing fruits, and enhanced sunlight penetration in the canopy may have improved quality. The findings for the enhancement of reducing sugar and non-reducing sugar quality parameters in Assam lemon are consistent with those of Nath (1994). Reducing sugars in fruits improved may be owing to adequate food delivery and activation of growth hormones, which promoted cell proliferation, according to Nath and Baruah (2001). The improved fruit quality could be explained by the fact that the varied nutrient sources improved plant capacity for greater uptake of nutrients from the rhizosphere, culminating in the conversion of acid to sugar and their derivatives via the reverse glycolytic pathway (Bohane and Tiwari, 2014).

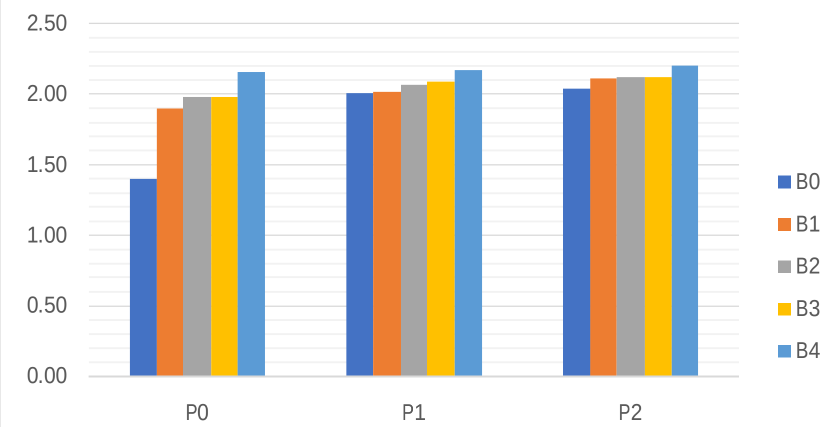

Fig. 2 Effect of pruning and biofertilizers on reducing sugar content in Assam lemon's fruit

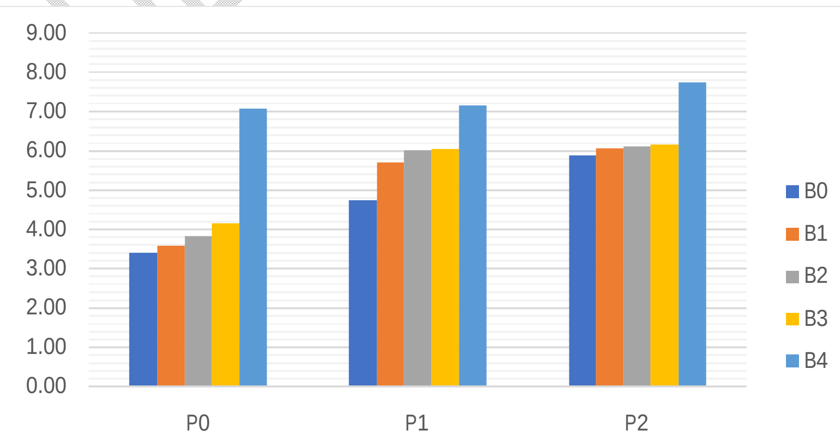

Fig. 3 Effect of pruning and biofertilizers on non-reducing sugar content in Assam lemon's fruit

Juice content (ml) and Juice pH

The amount of trimming has a significant impact on the juice content (Fig. 4). The treatment pruning 50% length of shoots (P_2) accumulated the higher amount of juice (33.81 ml), while the un-pruned (P_0) condition yielded the least (28.33 ml).

Similarly, the application of biofertilizer levels had a significant impact on juice content. Treatment B_4 (PGPR + Trichoderma + Azotobacter) yielded the maximum juice (36.97 ml), while treatment B_0 (No- biofertilizers) yielded the least (28.67 ml). Furthermore, the interaction of pruning and biofertilizer levels had a significant influence on juice content, with P_2B_4 (50% pruning + PGPR + Trichoderma + Azotobacter) producing the most juice (40 ml) and P_0B_1 (No pruning + PGPR) producing the least (26.37 ml). When Shamseldin *et al.* (2010) investigated microbial bio-fertilization options to boost the yield and quality of Washington navel orange, they discovered a similar outcome. They discovered that inoculating bio-fertilizer with Pseudomonas fluorescence strain 843 growth-boosting rhizobacteria boosted the juice content of Washington navel oranges substantially.

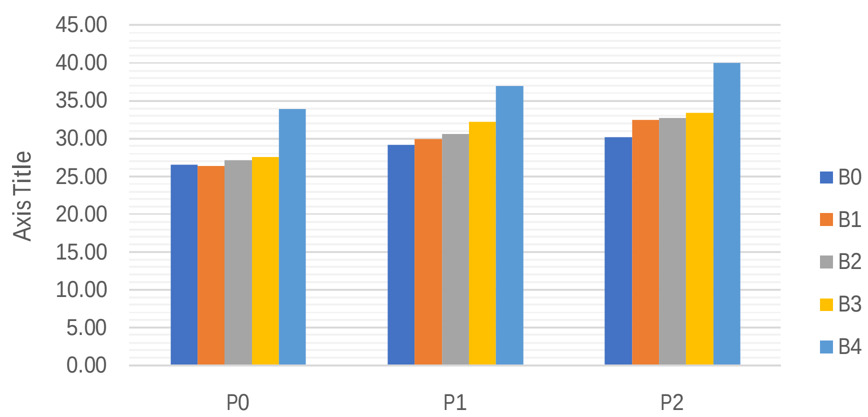

Fig. 4 Effect of pruning and biofertilizers on juice content (ml) in Assam lemon's fruit

Pruning had a significant influence (Fig. 5) on juice pH, with the treatment pruning 50% of the length of the shoots (P_2) having the greatest juice pH (2.08), and the un-pruned (P_0) having the lowest juice pH (2.00). Furthermore, the application of biofertilizer levels had a significant influence on the juice pH content of Assam lemon, according to the research. B_4 (PGPR + Trichoderma + Azotobacter) had the highest juice pH (2.14), while B_0 (No-biofertilizers) had the lowest (1.99). Similarly, the interaction between pruning and biofertilizer levels had no effect on juice pH, with the highest juice pH (2.23) recorded in the treatment pruning 50% + PGPR + Trichoderma + Azotobacter (P_2B_4) and the lowest (1.96) seen in the treatment combinations P_0B_1 (No pruning + PGPR) and P_0B_0 (control).

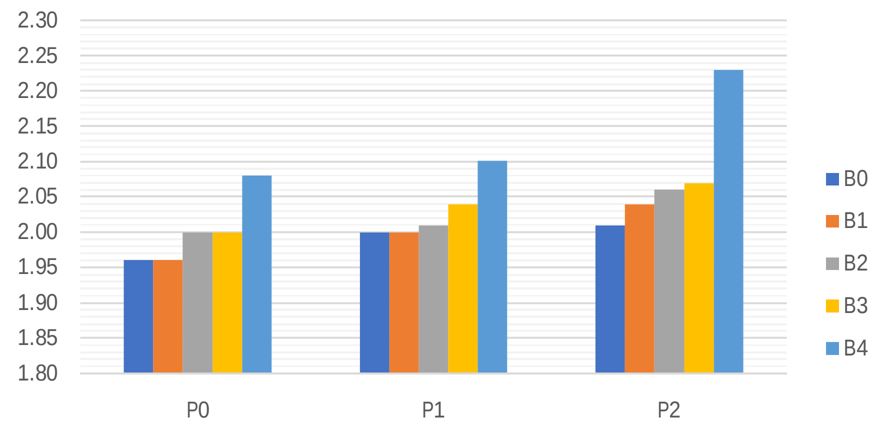

Fig. 5 Effect of pruning and biofertilizers on juice pH in Assam lemon's fruit

Table 03: Effects of pruning severity and biofertilizers on biochemical characteristics of Assam lemon fruits.

Treatments	Reducing sugar (%)	Non-reducing sugar	Juice pH	Juice content (ml)
(A) Effect of Pruning Severity				
P_0	1.88	4.41	2.00	28.33
P_1	2.07	5.94	2.03	31.80
P_2	2.12	6.39	2.08	33.81
S.Em ±	0.004	0.010	0.004	0.046
C.D. 0.05%	0.012	0.029	0.012	0.134
(B) Effect of Biofertilizers				
B_0	1.82	4.68	1.99	28.67
B_1	2.01	5.12	2.00	29.62
B_2	2.06	5.32	2.02	30.18
B_3	2.06	5.46	2.04	31.11
B_4	2.18	7.33	2.14	36.97
S.Em ±	0.007	0.016	0.007	0.077
C.D. 0.05%	0.012	0.048	0.012	0.223
Effect of (AXB) Interaction				
P_0B_0	1.40	3.41	1.96	26.58
P_0B_1	1.90	3.59	1.96	26.37
P_0B_2	1.98	3.82	2.00	27.17
P_0B_3	1.98	4.17	2.00	27.58
P_0B_4	2.16	7.08	2.08	33.92
P_1B_0	2.01	4.74	2.00	29.17
P_1B_1	2.02	5.71	2.00	30.00
P_1B_2	2.07	6.02	2.01	30.58
P_1B_3	2.09	6.04	2.04	32.25

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P_1B_4	2.17	7.16	2.10	37.00
P_2B_0	2.04	5.88	2.01	30.25
P_2B_1	2.11	6.07	2.04	32.50
P_2B_2	2.12	6.12	2.06	32.79
P_2B_3	2.12	6.16	2.07	33.50
P_2B_4	2.20	7.75	2.23	40.00
S.Em ±	0.021	0.049	0.020	0.231
C.D. 0.05%	0.061	0.143	0.059	0.669

CONCLUSION

From the study, it was concluded that the high pruning intensity (50% from the apex) and biofertilizers combination were found vital in Assam lemon`s fruit morphological (fruit length, fruit width, fruit volume, fruit weight, peel weight, and the number of seeds per fruit) and biochemical characteristics (TSS, titratable acidity, ascorbic acid, total sugar, reducing sugar and juice content).

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