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Synergistic effects of IBA, NAA and growing media on shoot initiation of peach cuttings

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Abstract

This study investigates "The effect of various plant growth hormones and cutting maturity on the growth and development of peach plants (*Prunus persica* L.)". The experiment was conducted at research field of School of Agriculture, Lovely Professional University, Punjab. It includes nine treatments which were (T1: soil + IBA@1000ppm, T2: soil + vermicompost + IBA@2000ppm, T3: soil + vermicompost + cocopeat + IBA@3000ppm, T4: soil + vermicompost + cocopeat + sand + IBA@4000ppm, T5: IBA@1000 ppm + NAA@1000 ppm, T6: IBA@2000 ppm + NAA@1000 ppm, T7: IBA@3000 ppm + NAA@1000 ppm, T8: IBA@4000 ppm + NAA@1000 ppm, T9: Control and replicated three times in a randomized block design. Peach cuttings were used from the local variety of district Mandi (Seraj), Himachal Pradesh. In terms of growth, it was observed that the T₂ (soil + vermicompost + IBA @2000ppm) shows superior results among all other treatments in shoot length (31.80 cm), Number of shoots per cutting (17.71 cm), Number of leaves per cutting (35.30), shoot diameter (2.70 mm), plant height (72.90 cm), leaf area (68.30 cm²), diameter of cuttings (10.03 mm), dry weight percentage of shoots (47.86 days), dry wt. of shoots (5.83 g), fresh wt. of shoots (12.18 g), sprouting percentage (75.30%), and days to sprouting (14.20 days).

Keywords: Cutting, growth, IAA, NAA, peach, shoot

Introduction

Prunus persica L. is the scientific name for the fruit-bearing plant that yields peaches. It's fascinating history begins in ancient China, from whence it travelled throughout many regions, changing its development patterns noticeably, especially in the Indian state of Punjab (Noori & Muhammad, 2020) [12]. Renowned botanist Linnaeus gave them the name *Amygdalus persica* for the first time in the seventeenth century. According to taxonomy, peaches belong to the *Prunus* genus and Rosaceae family. More specifically, they belong to the Rosales order and the Prunodieae subfamily. One interesting aspect about plants is that they are incredibly diverse, with peaches having a chromosomal count of 2n = 16 (Marwah & Kumar, 2022) [10]. Peaches, being high in antioxidants and dietary fiber, help with constipation relief, digestion, and weight management (Kaur & Kaur, 2020) [5]. Peaches provide a bountiful crop, either through self-pollination or with the assistance of hardworking insect pollinators. Peach trees are propagated using intriguing methods such as clonal propagation, grafting, and budding (Aranzazu & Font i Forcada, 2018) [1].

After pears and apples, peaches are considered the third most valuable temperate fruit in terms of botany. They go by several colloquial names, including "Aaru." In Unani tradition, they are referred to as "Aaadu" and "Khokh." Because of their versatility, prunus fruits and seeds can be utilized in a range of processing techniques, including jam-making (Le *et al.* 2018) [8] claim that when it comes to the quantity of phenolic compounds that peaches contribute to our diets, they are superior to stone fruits. Their distinct flavor, aroma, and health-promoting properties are caused by a variety of diverse substances (Zeb & Ahmad, 2019) [17]. These natural resources have significantly more beneficial impacts on our overall health than just satisfying our palates (Singh & Kaur, 2021) [6]. Plant growth regulators, or PGRs, are commonly used in cutting propagation to promote root growth and increase seedling survival. Auxins, the focus of botanical research, play a pivotal role in plant growth. Derived from the Greek term "auxin," which translates to "to grow," these plant hormones regulate various cellular processes (Rubio *et al.*, 2015) [13]. Auxins, like conductors in a complex symphony, orchestrate cell division, expansion, and differentiation. They regulate the growth

and development not only of peach trees but also of a diverse array of other plant species (Frick and Strader, 2017) [3]. Cytokinins, essential for plant development, have undergone extensive research regarding their actions, metabolism, and signaling pathways. However, our understanding of cytokinin transit remains limited (Li *et al.*, 2019) [8]. The main goal of this study is to observe the effect of PGRs and growing medias on shoot initiation of peach cuttings.

Material and methods

A research project titled "Synergistic Effects of IBA, NAA,

and Growing Media on Shoot Initiation of Peach Cuttings" was examined at the research field of School of Agriculture, Lovely Professional University, Punjab. The primary objective of this study is to investigate how plant growth hormones and cutting maturity affect the growth and development of peach plants. The experiment was laid down in RBD with 9 treatments and 3 replications. The cuttings were taken from the Himalayan temperate region of block Seraj, district Mandi (Himachal Pradesh). The geographical coordinates of LPU fruit nursery site are [31.2196° N latitude, 75.7797° E longitude].

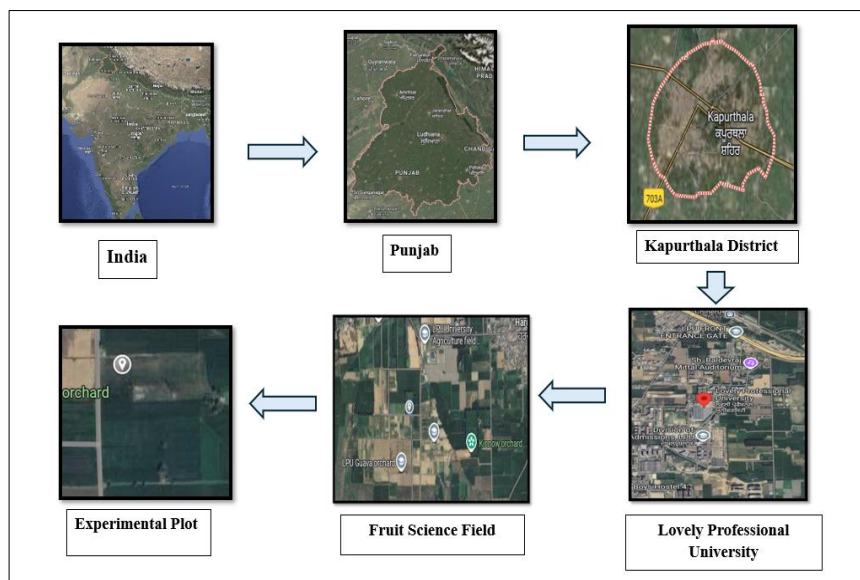


Plate 1: The geographical coordinates of LPU fruit nursery site are [31.2196° N latitude, 75.7797° E longitude]

Preparation of cuttings

Cuttings were prepared from the 12 years old wild tree of peach (Kateru or commonly known as Piuni aru). Hardwood cuttings were taken on the end of the January. Year-old cuttings were taken and wrap in a plastic bag and brought to the trial laboratory and field in LPU.

Preparation of growth regulator formulations

A small amount of ethanol was used to dissolve 1g, 2g, 3g, and 4g of IBA and 1g of NAA to create the growth regulators IBA (1000 ppm) and NAA (1000 ppm). After that, distilled water was added to reach a total capacity of 1000 ml. The solutions were prepared by dissolving in 50% ethanol with different concentration of IBA and NAA.

Planting of cuttings

The cuttings treated with different concentrations of chemicals are planted in polybags with three replications in each treatment. A frequent irrigation facility is applied to the cuttings at regular interval from the survival of the cutting from harsh period. The data was taken as 30 days interval for 3 months and then after one year the plants were sown in the main field.

Preparation of growth regulator formulations

A small amount of ethanol was used to dissolve 1g, 2g, 3g, and 4g of IBA and 1g of NAA to create the growth regulators IBA (1000 ppm) and NAA (1000 ppm). After that, distilled water was added to reach a total capacity of

1000 ml. Cuttings were dipped in formulation for 5 minutes before planting.

Sprouting percentage (%)

Calculated by multiplying the total number of cuttings sprouted with hundred and then dividing with total number of cuttings.

$$\text{Sprouting Percentage (\%)} = \frac{\text{Number of Cuttings Sprouted}}{\text{Total Number of Cuttings}} \times 100$$

Fresh weight of shoot (g)

The fresh weight of the shoots per cutting was measured using an electronic scale, and the average values were computed.

Dry weight of shoot (g)

The shoots were totally oven dried at 60 °C for 48 hours until a steady dry weight was achieved, and the dry weights were recorded using an electronic scale.

Dry weight percentage of shoot (%)

Calculated by multiplying dried weight of shoot with hundred and then dividing with fresh weight of shoot.

$$\text{Dry Weight Percentage of Shoot (\%)} = \frac{\text{Dry Weight of Shoot}}{\text{Fresh Weight of Shoot}} \times 100$$

To identify whether treatments exhibited significant differences in the traits or qualities under study, we

statistically analyzed the experimental data. The Panse and Sukhatme (1967) ANOVA technique was applied to find significant changes at the five percent significance level, as

advised for the Completely Randomized Block Design. Tukeys and posthoc statistical methods are used for comparing treatments.



Plate 2: Planting of cuttings in polybags, treated with different concentrations of IBA and NAA.

Treatments

T1: soil + IBA@1000ppm, T2: soil + vermicompost + IBA @2000ppm, T3: soil + vermicompost + cocopeat + IBA@3000ppm, T4: soil + vermicompost + cocopeat + sand + IBA@4000ppm, T5: IBA@1000 ppm + NAA@1000 ppm, T6: IBA@2000 ppm + NAA@1000 ppm, T7: IBA@3000 ppm + NAA@1000 ppm, T8: IBA@4000 ppm + NAA@1000 ppm, T9: Control. In control the cuttings were planted directly in soil without application of PGR.

Results and discussion

According to the data shown in Table 1 and Figure 1, the result was obtained by using T2 (soil + vermicompost + IBA @2000ppm) found superior comparatively other treatments in various parameters like days to sprouting, sprouting percentage (%), fresh weight of shoot (g), dry weight of shoot (g), diameter of cuttings (mm), leaf area (cm²). T8 (IBA@4000 ppm + NAA@1000 ppm), showed the least performance in days to sprouting at 30 days (18) took maximum number of days, sprouting percentage at 30 days (57.50%), fresh weight of shoot (6.12 g), dry weight of shoots (2.18 g), diameter of cuttings (8.52 mm) and minimum leaf area was observed in also the same (25.08cm²). The addition of organic amendments, particularly vermicompost and cocopeat, appeared to have a good effect on the number of days it took to sprout. Treatments T2 and T3 (both containing vermicompost) began sprouting earlier than the control group (T9), showing that organic matter may have a function in promoting root growth. The control group (T9) had a days-to-sprouting value of 17.30, indicating the baseline length without any interventions. While some treatments resulted in faster sprouting, it is important to note that the control showed a rather modest time for sprouting commencement. The average number of days required for sprouting was 16.20, with a range of 14.20 to 18.80 days. The earliest sprouting was observed in T2 and T5 (14.20 days), whereas T8 had the longest delay (18.80 days). The percentage of sprouts varied significantly between treatments, with T2 having the most (75.30%), followed by T9 (67.40%), and T1 having the lowest (55.80%). Shoot fresh weight at 30 days ranged from 6.12 g (T8) to 12.18 g (T2), with an average of 7.47 g. At 90 days, dry shoot weight ranged from 1.87 g (T1) to 5.83 g (T2), with an average of 2.69 g. Similarly, dry matter percentages were highest in T2 (47.86%) and lowest in T1

(29.08%), with a mean of 35.09% across treatments. (Sourati *et al.*, 2022) studied the effects of naphthaleneacetic acid (NAA) and indole-3-butyric acid (IBA) on mulberry cuttings. Interestingly, combining 1000 ppm of NAA with IBA resulted in a taller shoot (31.67 cm), a considerable increase in the number of leaves per cutting (21.67 cm), and faster sprouting (within 4.33 days). Shoot diameter at 90 days varied significantly less, ranging from 8.52 mm (T8) to 10.03 mm (T2), with an overall mean of 9.51 mm. Leaf area varied significantly, with the highest reported in T2 (68.30 cm²) and the lowest in T8 (25.08 cm²), compared to a mean of 45.30 cm² at 90 days. auxins stimulate cambial activity, enhance cell division and elongation, and promote the formation of rooting-related enzymes such as peroxidases and polyphenol oxidases, which collectively support adventitious root initiation. Statistical analysis, including the Critical Difference (C.D.) and Standard Error (SE) values, confirms the observed differences between treatments. There was little variation in the number of days needed to begin sprouting (SE(m) ± 0.32 ; CD 0.32), indicating that variations longer than 0.32 days are considered significant. Sprouting percentage exhibited moderate precision (SE(m) ± 0.80 ; CD 2.40), indicating that treatment differences above 2.40% are meaningful. Very low SE(m) values (± 0.08 g and ± 0.07 g, respectively) and comparably modest CD values (0.25 g and 0.21 g) were reported for fresh and dried shoot weights, indicating great measurement accuracy and sensitivity to even little variations among treatments. Moderate levels of experimental variability were also seen in the dry weight percentage (SE(m) ± 0.51 ; CD 1.54), cutting width (SE(m) ± 0.29 ; CD 0.86), and leaf area (SE(m) ± 0.49 ; CD 1.47). Overall, the statistical robustness of the experimental design is confirmed by the low SE(m) and CD values across the majority of factors. The C.D. value suggests that differences beyond this threshold are statistically significant, adding validity to the stated findings. The combination of vermicompost and IBA promotes more substantial early development in cuttings. The increased leaf area found in T2 indicates a larger photosynthetic surface, which most likely contributed to the higher dry matter accumulation observed in this treatment. Because leaf area and biomass are closely connected with cutting survival and vigor, the findings suggest that a modest dose of auxin paired with organic supplements is the most successful method for peach propagation. To promote

root formation, IBA was sprayed on hardwood branches 20-25 cm long and 0.5-1.0 cm in diameter (Tavares *et al.*, 2019) ^[16]. Plant development and water status are

inextricably linked since the growth of extensions requires turgidity in the cell. Reduced water content leads cells to constrict, resulting in less leaf area (Chhukit, 2009) ^[2].

Table 1- Effect of different treatments on days taken to start sprouting, sprouting percentage, fresh weight of shoot (g), dry weight of shoot(g), dry weight percentage of shoot (%), diameter of cuttings (mm), leaf area (cm²)

Treatment	Days taken to start sprouting. (30 Days)	Sprouting percentage (%) (30 Days)	Fresh weight of shoot (g) (90 Days)	Dry weight of shoot (g) (90 Days)	Dry weight percentage of shoot (90 Days)	Diameter of cuttings (mm) (90 Days)	Leaf area (cm ²) (90 Days)
T1	17(B)	55.80(A)	6.43(C)	1.87(A)	29.08(A)	9.21(C)	40.10(C)
T2	14(A)	75.30(E)	12.18(H)	5.83(G)	47.86(D)	10.03(C)	68.30(G)
T3	16(B)	62.70(C)	7.31(F)	2.34(E)	32.01(B)	9.71(C)	38.30(B)
T4	14(A)	59.80(B)	8.16(G)	2.67(F)	32.72(B)	9.91(C)	40.40(C)
T5	14(A)	62.30(C)	6.87(E)	2.12(B)	30.85(A)	9.61(C)	51.30(E)
T6	18(C)	63.80(C)	6.65(D)	2.32(E)	34.88(B)	9.83(C)	57.60(F)
T7	14(A)	60.20(B)	7.21(F)	2.66(F)	36.89(C)	9.06(B)	49.30(D)
T8	18(C)	57.50(A)	6.12(A)	2.18(C)	35.62(B)	8.52(A)	25.08(A)
T9	17(B)	67.40(D)	6.29(B)	2.26(D)	35.93(B)	9.74(C)	37.30(B)
Mean	15.78	62.76	7.47	2.69	35.09	9.51	45.30
C.D. at 5%	1.2	2.40	0.25	0.21	1.54	0.86	1.47
SE(m)±	0.32	0.80	0.08	0.07	0.51	0.29	0.49

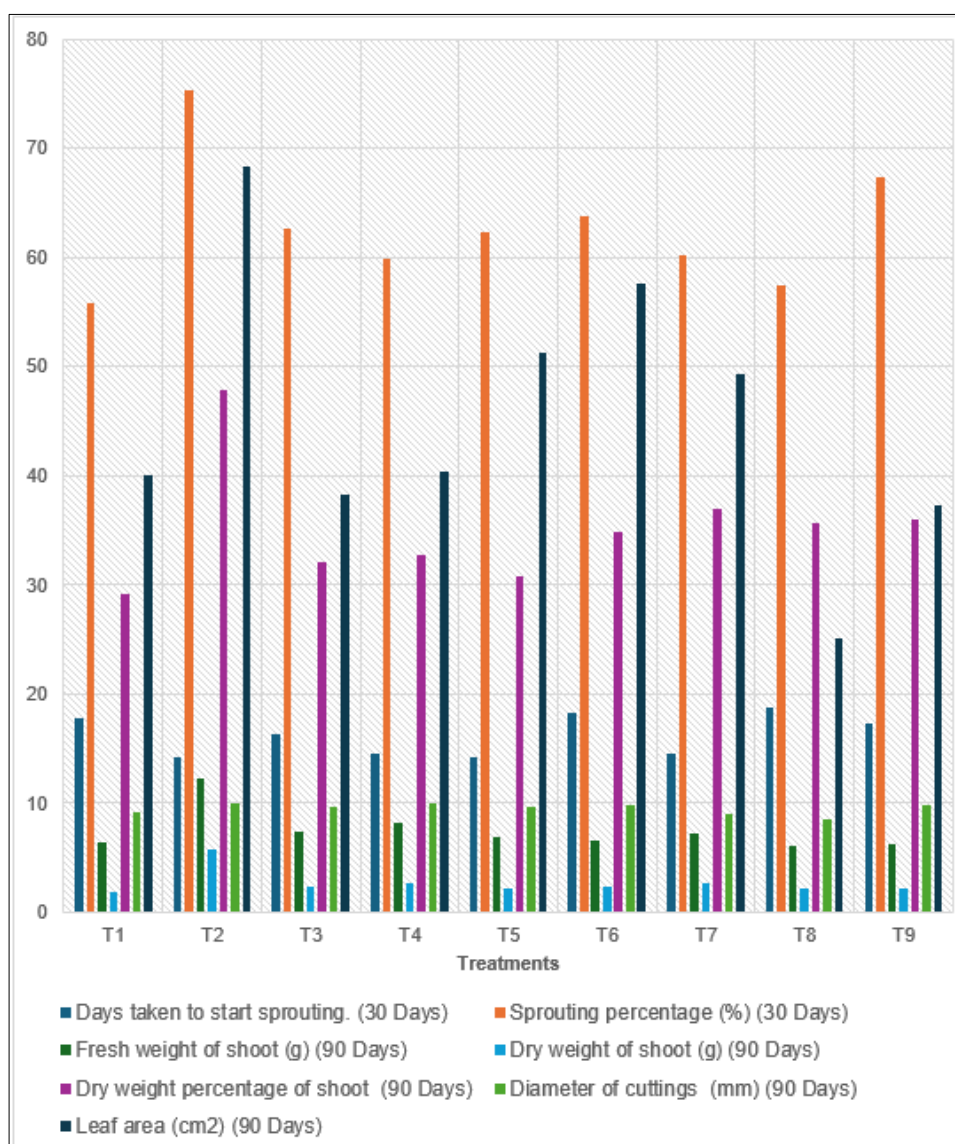


Fig 1: Effect of different treatments on days taken to start sprouting, sprouting percentage, fresh weight of shoot (g), dry weight of shoot(g), dry weight percentage of shoot (%), diameter of cuttings (mm), leaf area (cm²)



Plate 3: Sprouting of shoots at 30 days



Plate 4: Length of shoots and leaf increases

As per Table 2 and Figure 2 found the maximum shoot length (31.80 cm), highest number of shoots per cutting (17.71), total number of leaves per cutting (35.30) in T₂ (soil + vermicompost + IBA@2000ppm). The minimum shoot length shoot length was examined in T₁ (soil + IBA@1000ppm) which was (15.42 cm), lowest number of shoots per cutting (8.40) found in T₈ (IBA@4000 ppm) + NAA@1000 ppm, total number of leaves per cutting (18.50) in T₉ (Control) found minimum in T₈ (IBA@4000 ppm + NAA@1000 ppm). The control group T₉ (18.90 cm) had moderate shoot length, demonstrating that spontaneous growth of Peach cuttings without the use of plant growth hormones is possible, but it may not match the growth achieved with hormone treatments. Table 2 and Figure 2 found the maximum diameter of shoot (2.70 mm) and plant height (72.90 cm) in T₂ (soil + vermicompost + IBA@2000ppm). The minimum shoot diameter (2.10 mm) and plant height (47.30 cm) is found in T₉ (Control) found minimum in T₈ (IBA@4000 ppm + NAA@1000 ppm). The T₁ had the lowest shoot diameter 2.10 mm at 90 days. This highlights the role that organic element, particularly vermicompost, play in encouraging robust branch development in peach cuttings Softwood cuttings from the tips, sides, and bases of peach trees, as well as from different harvesting methods (in early, mid-, and late June),

can be utilized to propagate the plants. Shoot length rose steadily from 30 to 90 days across all treatments, with mean values of 1.27 cm, 6.14 cm, and 21.02 cm at 30, 60, and 90 days, respectively. At 90 days, T₂ had the longest shoot length (31.80 cm), followed by T₃ (22.65 cm) and T₄ (23.75 cm), with T₈ having the shortest (17.20 cm). There were significant differences between treatments at all phases, with T₂ consistently outperforming the others. The number of shoots per cutting varied considerably between treatments, with mean values of 6.83, 8.28, and 10.56 at 30, 60, and 90 days, respectively. At 90 days, T₂ produced the most shoots (17.71), while T₈ produced the fewest (8.40). Treatments T₃ (11.44) and T₄ (10.70) outperformed the mean at 90 days. The peach cultivars Shan-e Punjab and Earli Grande sprouted the most when exposed to 2000 ppm IBA. This experiment involves grafting two distinct peach types onto the 'Flordaguard' peach rootstock (Gill *et al.*, 2014) [4]. Leaf output followed a similar pattern, with averages of 3.91, 14.48, and 25.10 leaves per cutting at 30, 60, and 90 days, respectively. At 90 days, T₂ had the most leaves (35.30), followed by T₄ (31.30), and T₉ had the fewest (18.50). Notably, T₂ increased by about 1.5 times the mean at the final observation. Shoot diameter varied surprisingly little between treatments, with mean values of 1.54 mm, 1.78 mm, and 2.33 mm at 30, 60, and 90 days, respectively. At 90 days, T₂ had the largest diameter (2.70 mm), followed by T₅ (2.46 mm) and T₇ (2.41 mm), with T₁ having the smallest (2.10 mm). Plant height steadily increased across all treatments, with mean values of 21.14 cm, 39.06 cm, and 58.62 cm at 30, 60, and 90 days, respectively. T₂ had the tallest plants at 90 days, measuring 72.90 cm, followed by T₃ (67.90 cm) and T₄ (64.80 cm). The shortest plants were found in T₈ (47.30 cm). The SE(m) values (± 0.12 , ± 0.27 , ± 0.91) and associated CD values (0.37, 0.79, 2.73) for shoot length at 30, 60, and 90 days indicate increasing variability over time, with variations larger than the CD deemed significant. With SE(m) ranging from ± 0.32 to ± 0.34 and CD ranging from 0.96 to 1.01, the number of shoots per cutting demonstrated reasonable precision throughout phases, suggesting that treatment effects surpassing these thresholds are statistically significant. With SE(m) values (± 0.28 , ± 0.42 , ± 0.74) and CD values (0.85, 1.25, 2.20), the total number of leaves per cutting showed comparable trends, indicating sufficient precision and sensitivity to detect treatment changes. With SE(m) values (± 0.28 , ± 0.42 , ± 0.74) and CD values (0.85, 1.25, 2.20), the total number of leaves per cutting showed comparable trends, indicating sufficient precision and sensitivity to detect treatment changes. With very low SE(m) (± 0.09 , ± 0.07 , ± 0.04) and CD values (0.26, 0.22, 0.11), the shoot diameter demonstrated great precision at every stage, indicating little experimental error. Low SE(m) values (± 0.15 , ± 0.59 , ± 0.68) and CD values (0.45, 1.76, 2.05) corroborated the accuracy of plant height measurements. After one to two minutes of treatment with various IBA doses, the Shan-i-Punjab peach cultivar's hardwood cuttings showed the highest plant concentration, rooting percentage, root thickness, and weight (Kaur, 2015) [6]. The gradual increase in shoot length, number of shoots, and leaf output over 30, 60, and 90 days demonstrates the progressive growth of cuttings, with T₂ consistently outperforming the mean values at each stage. T₂'s higher performance can be due to the combination of IBA at 2000 ppm and vermicompost, which provided hormonal stimulation, resulting in increased

sprouting and vegetative development. These findings confirm previous findings that peach cuttings treated with

IBA had increased sprouting, rooting percentage, and overall growth vigor (Gill *et al.*, 2014; Kaur, 2015) ^[4, 6].

Table 2- Effect of different treatments on shoot length (cm), number of shoots per cutting, total number of leaves per cutting, diameter of shoot (mm) and plant height (cm)

Treatment	Shoot length (cm)			Number of shoots per cutting			Total number of leaves per cutting			Diameter of shoot (mm)			Plant height (cm)		
	30 (Days)	60 (Days)	90 (Days)	30 (Days)	60 (Days)	90 (Days)	30 (Days)	60 (Days)	90 (Days)	30 (Days)	60 (Days)	90 (Days)	30 (Days)	60 (Days)	90 (Days)
T1	0.55 (H)	4.24 (F)	15.42 (G)	5.33 (D)	5.63 (E)	9.70 (D)	5.70 (B)	11.23 (E)	20.00 (F)	1.65 (C)	1.82 (D)	2.10 (E)	19.30 (G)	36.70 (D)	52.80 (D)
T2	1.95 (B)	9.58 (A)	31.80 (A)	11.08 (A)	11.70 (A)	17.71 (A)	6.80 (A)	18.93 (A)	35.30 (A)	1.68 (B)	1.81 (D)	2.70 (A)	19.70 (F)	47.30 (A)	72.90 (A)
T3	1.84 (C)	8.60 (B)	22.65 (C)	7.85 (B)	8.56 (C)	11.44 (A)	4.20 (C)	14.89 (C)	25.70 (C)	1.58 (D)	1.86 (C)	2.30 (C)	20.30 (E)	42.40 (B)	67.90 (B)
T4	0.96 (F)	6.38 (C)	23.75 (B)	6.50 (C)	9.30 (B)	10.70 (C)	3.60 (D)	15.85 (B)	31.30 (B)	1.38 (D)	1.75 (E)	2.15 (E)	23.30 (B)	40.20 (C)	64.80 (C)
T5	1.23 (D)	4.76 (E)	20.76 (D)	6.30 (C)	8.30 (C)	9.30 (D)	2.81 (F)	9.18 (F)	23.80 (D)	1.23 (E)	1.52 (G)	2.46 (B)	19.40 (G)	42.10 (B)	64.20 (C)
T6	1.99 (A)	6.45 (C)	19.70 (E)	5.70 (D)	7.50 (D)	9.70 (D)	1.70 (G)	13.76 (D)	21.75 (E)	1.25 (E)	1.59 (F)	2.31 (C)	20.60 (E)	38.20 (D)	51.90 (E)
T7	1.22 (E)	5.80 (D)	18.98 (E)	6.30 (C)	8.40 (C)	9.30 (D)	4.30 (C)	16.87 (B)	24.80 (C)	1.68 (B)	1.93 (A)	2.41 (B)	21.40 (D)	37.12 (D)	53.20 (D)
T8	0.78 (G)	2.59 (G)	17.20 (F)	5.50 (D)	7.20 (D)	8.40 (F)	2.93 (F)	14.76 (C)	24.78 (C)	1.69 (B)	1.89 (B)	2.22 (D)	22.70 (C)	32.30 (F)	47.30 (F)
T9	0.95 (F)	6.86 (C)	18.90 (E)	6.87 (C)	7.90 (D)	8.80 (E)	3.12 (E)	14.89 (C)	18.50 (G)	1.72 (A)	1.82 (D)	2.34 (C)	23.60 (A)	35.20 (E)	52.60 (D)
Mean	1.27	6.14	21.02	6.83	8.28	10.56	3.91	14.48	25.10	1.54	1.78	2.33	21.14	39.06	58.62
C.D. at 5%	0.37	0.79	2.73	1.58	0.96	1.01	0.85	1.25	2.20	0.26	0.22	0.11	0.45	1.76	2.05
SE(m)±	0.12	0.27	0.91	0.53	0.32	0.34	0.28	0.42	0.74	0.09	0.07	0.04	0.15	0.59	0.68

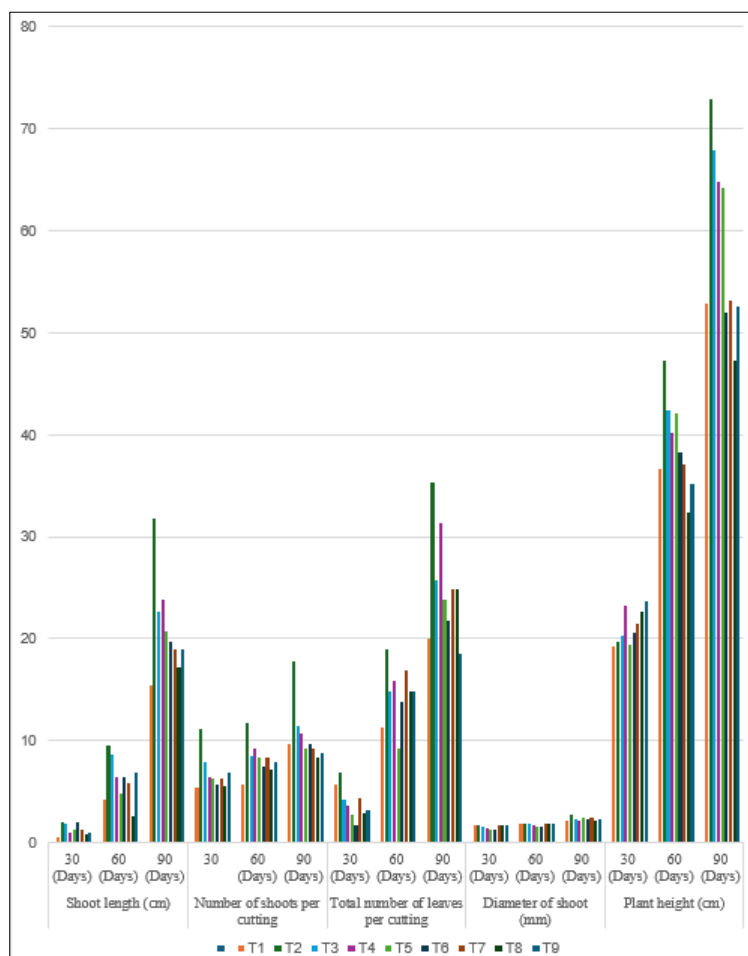


Fig 2: Effect of different treatments on shoot length (cm), number of shoots per cutting, total number of leaves per cutting, diameter of shoot (mm) and plant height (cm)

Conclusion

Studies conducted on the propagation of peach cuttings demonstrate the significant impact that soil amendments and plant growth hormones have on plant development. The synergistic effects of naphthaleneacetic acid (NAA) and indole-3-butyric acid (IBA) combinations highlight the significance of hormone balance in promoting ideal growth. Vermicompost is an excellent source of organic amendments that greatly improve shoot weight, diameter, early sprouting, and leaf area all of which demonstrate how important they are for maintaining plant health. These results provide producers with useful information to enhance fruit output and improve cutting propagation processes. Growers can attain sustainable peach output through the optimization of nutrient uptake and the establishment of a favorable growth environment. Additional factors influencing plant development and creative ways for improving productivity in a variety of environmental circumstances could be the subject of future research.

Conflict of interest

We have no conflicts of interest to disclose. All Authors declare that there is no conflict of interest in the research work and submitted manuscript.

Funding Declaration

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Competing Interests

No Competing Interests

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