



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.422>

EFFECT OF ROOTING HORMONE AND MEDIA ON GROWTH AND DEVELOPMENT IN HARDWOOD STEM CUTTINGS OF WATER APPLE (*SYZYGIUM AQUEUM* BRUM. F. ALSTON) UNDER SHADENET CONDITIONS

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(Date of Receiving : 06-11-2025; Date of Acceptance : 12-01-2026)

ABSTRACT

A study entitled “Effect of rooting hormone and media on growth and development in hardwood stem cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)] under shadenet conditions” was carried out during 2024-25 at College of Horticulture, Dr. Y.S.R. Horticultural University, West Godavari district, Andhra Pradesh. The experiment was laid out in factorial randomized block design (FRBD) with two replications. In total, sixteen treatment combinations were evaluated derived from two experimental factors each at four different levels *viz.*, rooting media at four levels [red earth + sand + cocopeat (2:1:1), red earth + sand + vermicompost (2:1:1), red earth + sand + vermicompost + cocopeat (2:1:1:1), red earth + sand (2:1)] and IBA concentrations at four levels (IBA 2000 ppm, IBA 3000 ppm, IBA 4000 ppm and water dipping). Among the both factors and interaction effects of rooting media and IBA concentrations in hardwood cuttings of water apple, red earth + sand + vermicompost (2:1:1) + IBA @ 3000 ppm recorded superior results with respect to all the following shoot and root growth parameters *viz.*, minimum number of days taken for sprout initiation (12.25 days), maximum number of sprouts (1.60, 5.30, 6.30, 7.30, 7.70, 7.90, 8.10 and 8.30 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively), shoot length (0, 9.13, 11.01, 12.47, 15.22, 18.50, 19.50 and 24.50 cm at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively), maximum leaf area (0, 29.51, 53.19, 57.01, 63.49, 70.29, 79.11 and 94.49 cm² at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively), maximum number of roots per cutting (23.30 at 120 DAP), maximum length of the roots per cutting (30.50 cm at 120 DAP), maximum length of the longest root (40.00 cm at 120 DAP), maximum fresh weight of the roots (7.23 g at 120 DAP) and maximum dry weight of the roots (5.34 g at 120 DAP). Whereas, survival percentage recorded non-significant differences among the interaction effect. Red earth + sand + vermicompost (2:1:1) with IBA concentration @ 3000 ppm was found to be the best treatment combination with respect to all the parameters in hardwood cuttings of water apple. Whereas, red earth + sand (2:1) + water dipping found to be the least treatment combination in all parameters.

Introduction

Water apple (*Syzygium aqueum* [Brum. F. Alston]), a notable minor fruit species from the Myrtaceae family, started in Jamaica in 1762 and extended to Hawaii by 1825. According to (Morton,

1987 and Djipa *et al.*, 2000), it is widely grown in tropical locations like South America, the warmer regions of North America, the Indian subcontinent, and sub-Saharan Africa. In India, this fruit is commonly seen in states like Kerala, Andhra Pradesh, Karnataka, West Bengal, Assam and Tripura. Its widespread

cultivation has been made possible by its capacity to adapt to a warmer climate. It is a tiny fruit, but it has horticultural value and regional significance. The ideal temperature range for vegetative development is between 25 and 30°C. The ideal temperature range for fruit development is between 15 and 25°C. These fruits are a good source of vitamins A and C as well as minerals including calcium and iron. The water apple's flesh is low in calories, high in flavonoids and phenolic compounds, almost 90% water, and well-known for its antioxidant properties. Water apple propagation is crucial for both home gardening and commercial production. When cultivated from seeds, water apples have a significant degree of genetic diversity and require a lengthy juvenile phase (4–7 years). Air layering, cuttings, and grafting are the commercial methods used to propagate water apples. Because of their effectiveness and rooting capabilities, cuttings are favoured over air layering. Water apple cuttings are good at rooted, and a single mother plant can produce many cuttings at once. In contrast, a single mother plant produces fewer layers in air layering. Water apple has been gaining popularity among both cultivators and consumers. However, one of the major hurdles in expanding its cultivation is the limited availability of planting material. This formed the background for the present investigation which aimed to produce quality planting material, entitled 'Effect of rooting hormone and media on growth and development in hard wood stem cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)] under shadenet conditions.' was conducted.

Materials and Methods

The present investigation entitled "Effect of rooting hormone and media on growth and development in hardwood stem cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)] under shadenet conditions" was carried out during 2024-2025, College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh. The experiment was laid out in Factorial Randomized Block Design and replicated twice. The four different types of rooting media *viz.*, red earth, sand, cocopeat and vermicompost were used. The rooting hormone Indole -3- butyric Acid (IBA) was used at three different concentrations and one as water dipping as control. The rooting media were prepared, by mixing red earth + sand and cocopeat in 2:1:1 ratio (M₁), red earth + sand and vermicompost in 2:1:1 ratio (M₂), red earth + sand and vermicompost + cocopeat in 2:1:1:1 ratio (M₃) and red earth + sand (M₄) respectively having four combinations of rooting media and Rooting Hormone (IBA) (H) H₁ - IBA 2000ppm, H₂ - IBA 3000 ppm, H₃ - IBA 4000ppm, H₄

- Water dipping used in the present investigation. In the present study a total of 16 different treatment combinations for rooting media and hormone were formed. In the present study, the following treatment combinations of IBA and media are used to treat the cuttings T₁ – Red earth + Sand + Cocopeat (2:1:1)+ IBA 2000ppm; T₂ – Red earth + Sand + Cocopeat (2:1:1)+ IBA 3000ppm; T₃ – Red earth + Sand + Cocopeat (2:1:1)+ IBA 4000ppm; T₄ – Red earth + Sand + Cocopeat (2:1:1); T₅ – Red earth + Sand + Vermicompost (2:1:1) + IBA 2000ppm; T₆ – Red earth + Sand + Vermicompost (2:1:1) + IBA 3000ppm; T₇ – Red earth + Sand + Vermicompost (2:1:1) + IBA 4000ppm; T₈ – Red earth + Sand + Vermicompost (2:1:1); T₉ – Red earth + Sand + Vermicompost + cocopeat (2:1:1:1) + IBA 2000ppm; T₁₀ – Red earth + Sand + Vermicompost + cocopeat (2:1:1:1) + IBA 3000ppm; T₁₁ – Red earth + Sand + Vermicompost + cocopeat (2:1:1:1) + IBA 4000ppm; T₁₂ – Red earth + Sand + Vermicompost + cocopeat (2:1:1:1); T₁₃ – Red earth + Sand (2:1) + IBA 2000ppm; T₁₄ – Red earth + Sand (2:1) + IBA 3000ppm; T₁₅ Red earth + Sand (2:1) + IBA 4000ppm; T₁₆ – Red earth + Sand (2:1). The results of shoot and root parameters are discussed here.

Preparation of cuttings

Hardwood cuttings (15 cm long) of water apple were taken from 8 years old shoots with a few nodes in each cutting. The small portions from both the ends of the cuttings slightly above and below the nodes were removed in order to separate the new shoots from the cuttings and trimmed them to the necessary length. The basal end of the cutting had a slant cut to promote the most absorbent area possible for successful roots in the hormonal solution. The treated cuttings were kept at 50 % shadenet of college farm.

Observations recorded

The treated cuttings were observed daily under each treatment for its sprouting. The number of days required for first sprouting was recorded and their mean was calculated for the days taken for first sprout to appear in each treatment and expressed in number for days taken to sprout initiation. Number of sprouts per cutting, shoot length, leaf area, was recorded at 15days interval starting from 15 DAP to 120 DAP. Number of roots per cutting, length of root per cutting, length of the longest root, fresh weight of the root, dry weight of the root were recorded at 120 days after transplanting.

Data Analysis: Analysis of experimental data recorded on various parameters of water apple cuttings was statistically analysed using analysis of variance

(ANOVA) employing Factorial Randomized Block Design.

Survival percentage (%)

The survival percentage was estimated at 120 days after planting by dividing the number of cuttings survived by total number of cuttings planted for each replication in each treatment and expressed as percentage with the following formula.

$$\text{Survival percentage of cuttings} = \frac{\text{Number of cuttings survived}}{\text{Total number of cuttings planted}} \times 100$$

Results and Discussion

Shoot parameters

Days taken for sprout initiation

Significant differences were recorded among different media with respect to number of days taken for sprout initiation. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M_2) (15.71 days) had recorded the minimum number of days taken for sprout initiation while maximum number of days taken for sprout initiation (22.18 days) was recorded in red earth+ sand (2:1) (M_4).

Among different concentrations of IBA, minimum number of days taken for sprout initiation was recorded in IBA @ 3000 ppm (H_2) (13.86 days). The maximum number of days taken for sprout initiation (23.38 days) was recorded in the cuttings treated without IBA treatment (H_4).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M_2H_2) had recorded minimum number of days taken for sprout initiation in hardwood cuttings of water apple (12.25 days) on par with (M_1H_2) of cuttings with IBA @ 3000 ppm planted in red earth + sand + cocopeat (2:1:1) (13.30 days) and (M_3H_2) of cuttings with IBA @ 3000 ppm planted in red earth + sand + vermicompost + cocopeat (2:1:1:1) (13.50 days). Red earth + sand media (2:1) treated without IBA (M_4H_4) recorded maximum number of days taken for sprout initiation (26.00 days).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had showed minimum number of days taken for sprout initiation. This might be due to the sufficient soil moisture coupled with nitrogen enrichment through vermicompost that creates a favourable environment for metabolic activity. When indole-3-butyric acid (IBA) is applied it further stimulates

essential cellular mechanisms such as division and elongation. This combined influence accelerates physiological processes thereby promoting quicker sprouting in stem cuttings. Similar results were reported by Vishal *et al.* (2023) in dragon fruit.

Number of sprouts per cutting

Significant differences were recorded among different media with respect to number of sprouts per cutting. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M_2) had recorded the maximum number of sprouts per cutting (0.98, 3.93, 4.93, 5.58, 5.98, 6.18, 6.38 and 6.58 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) while minimum number of sprouts produced (0.23, 2.00, 2.98, 3.40, 3.80, 4.00, 4.18 and 4.38 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in red earth+ sand (2:1) (M_4).

Among different concentrations of IBA, maximum number of sprouts produced was recorded in IBA @ 3000 ppm (H_2) (1.13, 4.03, 5.03, 5.58, 6.00, 6.18, 6.39 and 6.61 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively). The minimum number of sprouts produced (0.05, 1.90, 2.88, 3.30, 3.70, 3.90, 4.08 and 4.28 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in the cuttings treated without IBA treatment (H_4).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M_2H_2) had recorded maximum number of sprouts produced in hardwood cuttings of water apple (1.60, 5.30, 6.30, 7.30, 7.70, 7.90, 8.10 and 8.30 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively). Red earth + sand media (2:1) treated without IBA (M_4H_4) recorded minimum number of sprouts per cutting (0.00, 1.20, 2.10, 2.50, 2.90, 3.10, 3.20 and 3.40 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had showed maximum number of sprouts. This might be due to the vermicompost enriched with bioactive compounds plays a crucial role in stimulating and hastening bud emergence when combined with elevated levels of IBA it further activates meristematic tissues by promoting cell division and elongation thereby enhancing shoot initiation. The results are in conformity with those reported by Upadhyay and Badyal (2007) in pomegranate and Vishal *et al.* (2023) in dragon fruit.

Shoot length (cm)

Significant differences were recorded among different media with respect to shoot length. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M_2) (0, 4.34, 6.29, 7.76, 8.83, 11.54, 12.14 and 15.15 cm at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) had recorded the maximum shoot length on par with (M_3) red earth + sand + vermicompost + cocopeat (2:1:1:1) media (6.98 cm) at 60 DAP while minimum shoot length (0, 1.83, 3.39, 4.19, 4.68, 5.68, 6.28 and 7.81 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in red earth+ sand (2:1) (M_4).

Among different concentrations of IBA, maximum shoot length was recorded in IBA @ 3000 ppm (H_2) (0, 5.45, 8.06, 9.63, 10.68, 13.15, 14.15 and 17.37 cm at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively). The minimum shoot length (0, 1.54, 2.85, 3.72, 4.22, 5.96, 6.16 and 7.39 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in the cuttings treated without IBA treatment (H_4).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M_2H_2) had recorded maximum shoot length in hardwood cuttings of water apple (0, 9.13, 11.01, 12.47, 15.22, 18.50, 19.50 and 24.50 cm at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) on par with (M_3H_2) of cuttings with IBA @ 3000 ppm and planted in red earth + sand + vermicompost + cocopeat (2:1:1:1) (11.40 cm) at 60 DAP. Red earth + sand media (2:1) treated without IBA (M_4H_4) recorded minimum shoot length (0, 1.12, 2.49, 2.77, 3.27, 4.52, 4.72 and 5.67 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had showed maximum shoot length. This might be due to the balanced supply of water and nutrients by vermicompost ultimately supported vigorous shoot growth and sugars served as an immediate energy source for meristematic tissues through enhanced respiration by IBA, thereby promoting cell division and enlargement, which contributed to greater shoot elongation. The results found similar with the findings of Kumar *et al.* (2022) in lemon.

Leaf area (cm²)

Significant differences were recorded among different media with respect to leaf area. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M_2) (0, 23.42, 38.24, 46.74, 53.59, 60.59, 69.20 and 76.95 cm² at 15, 30, 45, 60, 75, 90, 105 and 120

DAP respectively) had recorded the maximum leaf area while minimum leaf area (0, 14.88, 23.60, 46.74, 33.98, 37.17, 40.99 and 47.70 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in red earth+ sand (2:1) (M_4).

Among different concentrations of IBA, maximum leaf area was recorded in IBA @ 3000 ppm (H_2) (0, 25.29, 41.56, 45.21, 47.48, 52.63, 59.19 and 68.62 cm² at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively). The minimum leaf area (0, 11.46, 19.84, 28.47, 34.70, 38.40, 43.13 and 48.14 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) was recorded in the cuttings treated without IBA treatment (H_4).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M_2H_2) had recorded maximum leaf area in hardwood cuttings of water apple (0, 29.51, 53.19, 57.01, 63.49, 70.29, 79.11 and 94.49 cm² at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively) on par with (M_2H_1) cuttings with IBA @ 2000 ppm planted in red earth + sand + vermicompost (2:1:1) (78.18 cm²) at 105 DAP. Red earth + sand media (2:1) treated without IBA (M_4H_4) recorded minimum leaf area (0, 9.59, 17.93, 22.99, 26.98, 30.07, 34.82 and 38.34 at 15, 30, 45, 60, 75, 90, 105 and 120 DAP respectively).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had showed maximum leaf area. This might be due to the vermicompost present in media contributed to better water retention in the medium and provided growth regulators and photosynthates that encouraged leaf cell division. Simultaneously, IBA boosted photosynthetic efficiency reinforcing physiological activity. Together these factors supported vigorous leaf growth and expansion ultimately achieving the highest leaf area. These results are in conformity with Siddiqui and Hussain (2007) and Bhat (2000) in pomegranate.

Survival percentage (%)

Significant differences were recorded among different media with respect to survival percentage. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M_2) (78.13 % at 120 DAP) had recorded the maximum survival percentage while minimum survival percentage (69.38 % at 120 DAP) was recorded in red earth+ sand (2:1) (M_4).

Among different concentrations of IBA, maximum survival percentage was recorded in IBA @ 3000 ppm (H_2) (85.00 % at 120 DAP). The maximum number of days taken for sprout initiation (65.00 % at

120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The interaction between different rooting media and rooting hormone was found to be non-significant with respect to survival percentage in hardwood cuttings. Cuttings treated with IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum survival percentage in hardwood cuttings of water apple (95.00 % at 120 DAP). Where red earth + sand media (2:1) treated without IBA (M₄H₄) recorded minimum survival percentage (62.50 % at 120 DAP).

Root parameters

Number of roots per cutting

Significant differences were recorded among different media with respect to number of roots per cutting. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M₂) (17.35 at 120 DAP) had recorded the maximum number of roots. Whereas, minimum number of roots (11.53 at 120 DAP) was recorded in red earth+ sand (2:1) (M₄).

Among different concentrations of IBA, maximum number of roots produced was recorded in IBA @ 3000 ppm (H₂) (19.35 at 120 DAP). The minimum leaf area (15.55 at 120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum number of roots in hardwood cuttings of water apple (23.30 at 120 DAP) and red earth + sand media (2:1) treated without IBA (M₄H₄) recorded minimum number of roots per cutting (7.90 at 120 DAP).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had recorded maximum number of roots. This might be due to the beneficial microbes present in vermicompost can suppress soil-borne pathogens, thereby creating healthier conditions for root establishment. In addition, the application of exogenous auxin (IBA) stimulates the hydrolysis of stored carbohydrates, ensuring energy availability that promotes the formation of a greater number of roots. The results are in consonance with the findings of Ausari *et al.* (2023) in grape.

Length of root per cutting (cm)

Significant differences were recorded among different media with respect to length of the roots per

cutting. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M₂) (21.93 cm at 120 DAP) had recorded the maximum length of the roots while minimum length of the roots (15.86 cm at 120 DAP) was recorded in red earth+ sand (2:1) (M₄).

Among different concentrations of IBA, maximum length of the roots was recorded in IBA @ 3000 ppm (H₂) (25.90 cm at 120 DAP). The minimum length of the roots (13.90 cm at 120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum length of the roots in hardwood cuttings of water apple (30.50 cm at 120 DAP) and red earth + sand media (2:1) treated without IBA (M₄H₄) recorded minimum length of the roots per cutting (12.00 cm at 120 DAP).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had showed better performance. This might be due to the nutrient and trace element supply combined with sufficient moisture and aeration provided by vermicompost present in media and cell wall flexibility which increases water permeability due to exogenous supply of auxin (IBA) resulting in cell enlargement leading to greater root length per cutting. Similar results were reported by Singh *et al.* (2018) in phalsa and Saini *et al.* (2021) in cuttings of pomegranate.

Length of the longest root (cm)

Significant differences were recorded among different media with respect to length of the longest root. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M₂) (28.93 cm at 120 DAP) had recorded the maximum length of the longest root while minimum length of the longest root (23.83 cm at 120 DAP) was recorded in red earth+ sand (2:1) (M₄).

Among different concentrations of IBA, maximum length of the longest root was recorded in IBA @ 3000 ppm (H₂) (34.59 cm at 120 DAP). The minimum length of the longest root (20.94 cm at 120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum length of the longest root in

hardwood cuttings of water apple (40.00 cm at 120 DAP) while red earth + sand media (2:1) treated without IBA (M₄H₄) recorded minimum length of the longest root (19.40 cm at 120 DAP).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had recorded length of the longest root. This might be due to the vermicompost present in media enriched the rooting substrate by prolonging nutrient availability while IBA driven respiration ensured efficient utilization of sugars to generate energy. The resulting boost in cellular activity supported rapid elongation of meristematic tissues leading to a significant increase in root length. Similar results were reported by Dilawar and Amarjeet (2024) in dragon fruit, Srivastava *et al.* (2005) in Kiwifruit.

Fresh weight of the root (g)

Significant differences were recorded among different media with respect to fresh weight of the root. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M₂) (5.28 g at 120 DAP) had recorded the maximum fresh weight of the root while minimum fresh weight of the root (2.56 g at 120 DAP) was recorded in red earth+ sand (2:1) (M₄).

Among different concentrations of IBA, maximum fresh weight of the root was recorded in IBA @ 3000 ppm (H₂) (5.16 g at 120 DAP). The minimum fresh weight of the root (2.66 g at 120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum fresh weight of the root in hardwood cuttings of water apple (7.23 g at 120 DAP). Whereas, red earth + sand media (2:1) treated without

IBA (M₄H₄) recorded minimum fresh weight of the root (1.95 g at 120 DAP).

Dry weight of the root (g)

Significant differences were recorded among different media with respect to dry weight of the root. The cuttings planted in red earth + sand + vermicompost (2:1:1) media (M₂) (4.15 g at 120 DAP) had recorded the maximum dry weight of the root while minimum dry weight of the root (1.68 g at 120 DAP) was recorded in red earth+ sand (2:1) (M₄).

Among different concentrations of IBA, maximum dry weight of the root was recorded in IBA @ 3000 ppm (H₂) (3.73 g at 120 DAP). The minimum dry weight of the root (2.63 g at 120 DAP) was recorded in the cuttings treated without IBA treatment (H₄).

The significant differences were recorded for the interaction effect of rooting hormone and media. IBA @ 3000 ppm and planted in red earth + sand + vermicompost (2:1:1) media treatment (M₂H₂) had recorded maximum dry weight of the root in hardwood cuttings of water apple (5.34 g at 120 DAP). Whereas, red earth + sand media (2:1) treated without IBA (M₄H₄) recorded minimum dry weight of the root (1.08 g at 120 DAP).

Treatment combination of red earth + sand + vermicompost mixture in (2:1:1) ratio and IBA @ 3000 ppm had recorded maximum fresh and dry weight of the roots. This might be due to the increase in root biomass by absorption of essential nutrients provided by the media and accumulation of photo assimilates produced by respiration of sugars by IBA activity resulting in maximum fresh and dry weight of roots. The findings were in close agreement with those of Varsha *et al.* (2021) in dragon fruit and Gul e-khanda *et al.* (2022) in phalsa.

Table 1 : Effect of rooting hormone and media on days taken for sprout initiation in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	Rooting Hormone (IBA) (H)				Mean (M)
	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	
M ₁ - Red earth + Sand + Cocopeat (2:1:1)	14.85	13.30	18.95	24.90	18.00
M ₂ - Red earth + Sand + Vermicompost (2:1:1)	14.30	12.25	15.55	20.75	15.71
M ₃ - Red earth + Sand + Vermicompost + cocopeat (2:1:1:1)	16.70	13.50	19.90	21.85	17.99
M ₄ - Red earth + Sand (2:1)	22.10	16.40	24.20	26.00	22.18
Mean(H)	16.99	13.86	19.65	23.38	
Factors	SE m±		CD at 5 %		
M	0.26		0.79		
H	0.26		0.79		
M x H	0.53		1.59		

Table 2 : Effect of rooting hormone and media on number of sprouts per cutting in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	Rooting Hormone (IBA) (H)																			
	15 DAP					30 DAP					45 DAP					60 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
M ₁	0.70	1.10	0.40	0.00	0.55	2.80	3.90	2.00	1.50	2.55	3.80	4.90	3.00	2.50	3.55	4.20	5.30	3.35	2.90	3.94
M ₂	1.20	1.60	0.90	0.20	0.98	3.80	5.30	3.50	3.10	3.93	4.80	6.30	4.50	4.10	4.93	5.50	7.30	5.00	4.50	5.58
M ₃	0.90	1.30	0.60	0.00	0.70	3.30	4.00	2.30	1.80	2.85	4.30	5.00	3.30	2.80	3.85	4.70	5.40	3.90	3.30	4.33
M ₄	0.30	0.50	0.10	0.00	0.23	2.20	2.90	1.70	1.20	2.00	3.20	3.90	2.70	2.10	2.98	3.70	4.30	3.10	2.50	3.40
Mean(H)	0.78	1.13	0.50	0.05		3.03	4.03	2.38	1.90		4.03	5.03	3.38	2.88		4.53	5.58	3.84	3.30	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.07		0.21			0.06		0.19			0.06		0.19			0.07		0.20		
H	0.07		0.21			0.06		0.19			0.06		0.19			0.07		0.20		
M x H	0.14		NS			0.13		0.38			0.13		0.38			0.13		0.39		
Media (M)	75 DAP					90 DAP					105 DAP					120 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
	M ₁	4.60	5.70	3.80	3.30	4.35	4.80	5.80	4.00	3.50	4.53	5.00	6.00	4.20	3.70	4.73	5.30	6.30	4.40	3.90
M ₂	5.90	7.70	5.40	4.90	5.98	6.10	7.90	5.60	5.10	6.18	6.30	8.10	5.80	5.30	6.38	6.50	8.30	6.00	5.50	6.58
M ₃	5.10	5.90	4.30	3.70	4.75	5.30	6.10	4.50	3.90	4.95	5.50	6.35	4.70	4.10	5.16	5.70	6.55	4.90	4.30	5.36
M ₄	4.10	4.70	3.50	2.90	3.80	4.30	4.90	3.70	3.10	4.00	4.50	5.10	3.90	3.20	4.18	4.70	5.30	4.10	3.40	4.38
Mean(H)	4.93	6.00	4.25	3.70		5.13	6.18	4.45	3.90		5.33	6.39	4.65	4.08		5.55	6.61	4.85	4.28	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.06		0.18			0.06		0.18			0.05		0.16			0.04		0.13		
H	0.06		0.18			0.06		0.18			0.05		0.16			0.04		0.13		
M x H	0.12		0.36			0.12		0.36			0.11		0.32			0.09		0.26		

Table 3 : Effect of rooting hormone and media on shoot length (cm) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	Rooting Hormone (IBA) (H)																			
	15 DAP					30 DAP					45 DAP					60 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
M ₁	0.00	0.00	0.00	0.00	0.00	2.53	4.21	1.64	1.31	2.42	5.38	7.10	3.32	2.67	4.62	5.91	8.35	3.69	2.88	5.21
M ₂	0.00	0.00	0.00	0.00	0.00	3.63	9.13	2.49	2.13	4.34	6.96	11.01	3.88	3.31	6.29	7.95	12.47	5.70	4.94	7.76
M ₃	0.00	0.00	0.00	0.00	0.00	3.46	5.40	1.74	1.61	3.05	6.46	8.96	3.66	2.96	5.51	7.32	11.40	4.90	4.29	6.98
M ₄	0.00	0.00	0.00	0.00	0.00	1.77	3.05	1.40	1.12	1.83	2.88	5.19	3.01	2.49	3.39	4.16	6.28	3.54	2.77	4.19
Mean(H)	0.00	0.00	0.00	0.00		2.85	5.45	1.82	1.54		5.42	8.06	3.47	2.85		6.33	9.63	4.46	3.72	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.00		0.00			0.07		0.20			0.16		0.49			0.27		0.82		
H	0.00		0.00			0.07		0.20			0.16		0.49			0.27		0.82		
M x H	0.00		0.00			0.14		0.41			0.32		0.97			0.55		1.64		
Media (M)	75 DAP					90 DAP					105 DAP					120 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
	M ₁	6.41	8.85	4.19	3.39	5.71	8.20	13.15	5.89	5.72	8.24	9.20	14.15	6.09	5.92	8.84	10.10	15.31	7.81	6.45
M ₂	8.45	15.22	6.20	5.45	8.83	12.15	18.50	8.11	7.41	11.54	13.15	19.50	8.31	7.61	12.14	16.55	24.50	9.42	10.14	15.15
M ₃	7.82	11.90	5.40	4.78	7.48	9.05	13.73	6.76	6.18	8.93	10.05	14.73	6.97	6.38	9.53	10.51	19.25	7.98	7.31	11.26
M ₄	4.66	6.77	4.04	3.27	4.68	5.29	7.25	5.66	4.52	5.68	6.29	8.25	5.86	4.72	6.28	8.07	10.41	7.07	5.67	7.81
Mean(H)	6.83	10.68	4.96	4.22		8.67	13.15	6.60	5.96		9.67	14.15	6.81	6.16		11.31	17.37	8.07	7.39	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.31		0.95			0.17		0.50			0.17		0.50			0.27		0.81		
H	0.31		0.95			0.17		0.50			0.17		0.50			0.27		0.81		
M x H	0.63		1.89			0.33		1.01			0.33		1.01			0.54		1.61		

Table 4 : Effect of rooting hormone and media on leaf area (sq.cm) in **hardwood cuttings** of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	Rooting Hormone (IBA) (H)																			
	15 DAP					30 DAP					45 DAP					60 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
M ₁	0.00	0.00	0.00	0.00	0.00	18.13	24.14	16.86	10.78	17.48	35.90	37.96	25.90	19.00	29.69	36.46	40.62	31.52	24.30	33.22
M ₂	0.00	0.00	0.00	0.00	0.00	26.88	29.51	23.88	13.43	23.42	40.80	53.19	36.66	22.33	38.24	47.18	57.01	46.38	36.40	46.74
M ₃	0.00	0.00	0.00	0.00	0.00	22.00	25.38	18.30	12.06	19.43	37.55	46.97	29.56	20.10	33.54	39.23	49.10	38.95	30.21	39.37
M ₄	0.00	0.00	0.00	0.00	0.00	16.89	22.16	10.88	9.59	14.88	26.74	28.12	21.62	17.93	23.60	29.65	34.14	27.91	22.99	28.67
Mean(H)	0.00	0.00	0.00	0.00		20.97	25.29	17.48	11.46		35.24	41.56	28.43	19.84		38.13	45.21	36.19	28.47	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.00		0.00			0.17		0.51			0.23		0.69			0.16		0.48		
H	0.00		0.00			0.17		0.51			0.23		0.69			0.16		0.48		
M x H	0.00		0.00			0.34		1.03			0.46		1.38			0.32		0.96		
Media (M)	75 DAP					90 DAP					105 DAP					120 DAP				
	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)	H ₁	H ₂	H ₃	H ₄	Mean (M)
	M ₁	37.28	41.53	36.71	32.21	36.93	43.36	46.51	39.36	34.37	40.90	49.93	55.51	46.39	41.41	48.31	60.05	61.10	57.90	49.06
M ₂	54.34	63.49	50.44	46.10	53.59	64.51	70.29	57.23	50.35	60.59	78.18	79.11	65.67	53.84	69.20	86.57	94.49	68.94	57.79	76.95
M ₃	42.95	46.23	39.60	33.52	40.57	45.79	51.44	46.49	38.81	45.63	51.35	56.64	51.48	42.46	50.48	61.59	63.65	57.32	47.38	57.48
M ₄	36.34	38.68	33.92	26.98	33.98	40.26	42.30	36.08	30.07	37.17	41.02	45.50	42.61	34.82	40.99	48.13	55.23	49.11	38.34	47.70
Mean(H)	42.73	47.48	40.17	34.70		48.48	52.63	44.79	38.40		55.12	59.19	51.53	43.13		64.08	68.62	58.32	48.14	
Factors	SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%			SE m ±		CD at 5%		
M	0.22		0.67			0.16		0.48			0.16		0.49			0.15		0.46		
H	0.22		0.67			0.16		0.48			0.16		0.49			0.15		0.46		
M x H	0.44		1.33			0.32		0.97			0.33		0.99			0.31		0.92		

Table 5 : Effect of rooting hormone and media on survival percentage (%) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	Rooting Hormone (IBA) (H)				
	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)
M ₁ - Red earth + Sand + Cocopeat (2:1:1)	72.50 (58.37)	80.00 (63.41)	67.50 (55.23)	65.00 (53.71)	71.25 (57.68)
M ₂ - Red earth + Sand + Vermicompost (2:1:1)	77.50 (59.97)	95.00 (67.47)	72.50 (56.84)	67.50 (53.75)	78.13 (59.51)
M ₃ - Red earth + Sand + Vermicompost + cocopeat (2:1:1:1)	75.00 (61.69)	85.00 (77.04)	70.00 (58.37)	65.00 (55.23)	73.75 (63.08)
M ₄ - Red earth + Sand (2:1)	70.00 (56.84)	80.00 (63.41)	65.00 (53.75)	62.50 (52.22)	69.38 (56.55)
Mean(H)	73.75 (59.22)	85.00 (67.83)	68.75 (56.05)	65.00 (53.73)	
Factors	SE m ±		CD at 5 %		
M	1.07		3.26		
H	1.07		3.26		
M x H	2.14		NS		

Table 6 : Effect of rooting hormone and media on number of roots per cutting in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	120 DAP				
	Rooting Hormone (IBA) (H)				
	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)
M ₁ - Red earth + Sand + Cocopeat (2:1:1)	15.10	18.35	12.50	9.10	13.76
M ₂ - Red earth + Sand + Vermicompost (2:1:1)	18.60	23.30	15.80	11.70	17.35
M ₃ - Red earth + Sand + Vermicompost + cocopeat (2:1:1:1)	15.50	20.50	13.65	10.55	15.05
M ₄ - Red earth + Sand (2:1)	13.00	15.25	9.95	7.90	11.53
Mean(H)	15.55	19.35	12.98	9.81	
Factors	SE m±		CD at 5 %		
M	0.14		0.43		
H	0.14		0.43		
M x H	0.28		0.85		

Table 7 : Effect of rooting hormone and media on length of root per cutting (cm) and length of the longest root (cm) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

Media (M)	120 DAP									
	Rooting Hormone (IBA) (H)									
	Length of root per cutting (cm)					Length of the longest root (cm)				
	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)
M ₁ - Red earth + Sand + Cocopeat (2:1:1)	16.30	23.80	14.45	12.60	16.79	24.90	32.90	22.20	20.30	25.08
M ₂ - Red earth + Sand + Vermicompost (2:1:1)	20.70	30.50	19.50	17.00	21.93	27.00	40.00	25.45	23.25	28.93
M ₃ - Red earth + Sand + Vermicompost + cocopeat (2:1:1:1)	17.30	26.05	15.35	14.00	18.18	26.00	33.95	23.55	20.80	26.08
M ₄ - Red earth + Sand (2:1)	15.20	23.25	13.00	12.00	15.86	24.05	31.50	20.35	19.40	23.83
Mean(H)	17.38	25.90	15.58	13.90		25.49	34.59	22.89	20.94	
Factors	SE m±			CD at 5 %		SE m±		CD at 5 %		
M	0.16			0.48		0.15		0.44		
H	0.16			0.48		0.15		0.44		
M x H	0.32			0.96		0.29		0.88		

Table 8 : Effect of rooting hormone and media on fresh weight and dry weight of the root (g) in hardwood cuttings of water apple

Media (M)	120 DAP									
	Rooting Hormone (IBA) (H)									
	Fresh weight of the root (g)					Dry weight of the root (g)				
	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)	H ₁ - IBA 2000ppm	H ₂ - IBA 3000ppm	H ₃ - IBA 4000ppm	H ₄ - Water dipping	Mean (M)
M ₁ - Red earth + Sand + Cocopeat (2:1:1)	2.89	4.13	2.30	2.11	2.86	1.82	2.88	1.45	1.16	1.83
M ₂ - Red earth + Sand + Vermicompost (2:1:1)	5.64	7.23	4.91	3.34	5.28	4.05	5.34	3.69	3.53	4.15
M ₃ - Red earth + Sand + Vermicompost + cocopeat (2:1:1:1)	3.89	5.76	3.51	3.24	4.10	2.97	3.98	2.56	2.45	2.99
M ₄ - Red earth + Sand (2:1)	2.75	3.51	2.05	1.95	2.56	1.67	2.73	1.25	1.08	1.68
Mean(H)	3.79	5.16	3.19	2.66		2.63	3.73	2.24	2.06	
Factors	SE m±			CD at 5 %		SE m±		CD at 5 %		
M	0.12			0.37		0.02		0.05		
H	0.12			0.37		0.02		0.05		
M x H	0.25			0.75		0.04		0.11		

[*Syzygium aqueum* (Brum. F. Alston)].

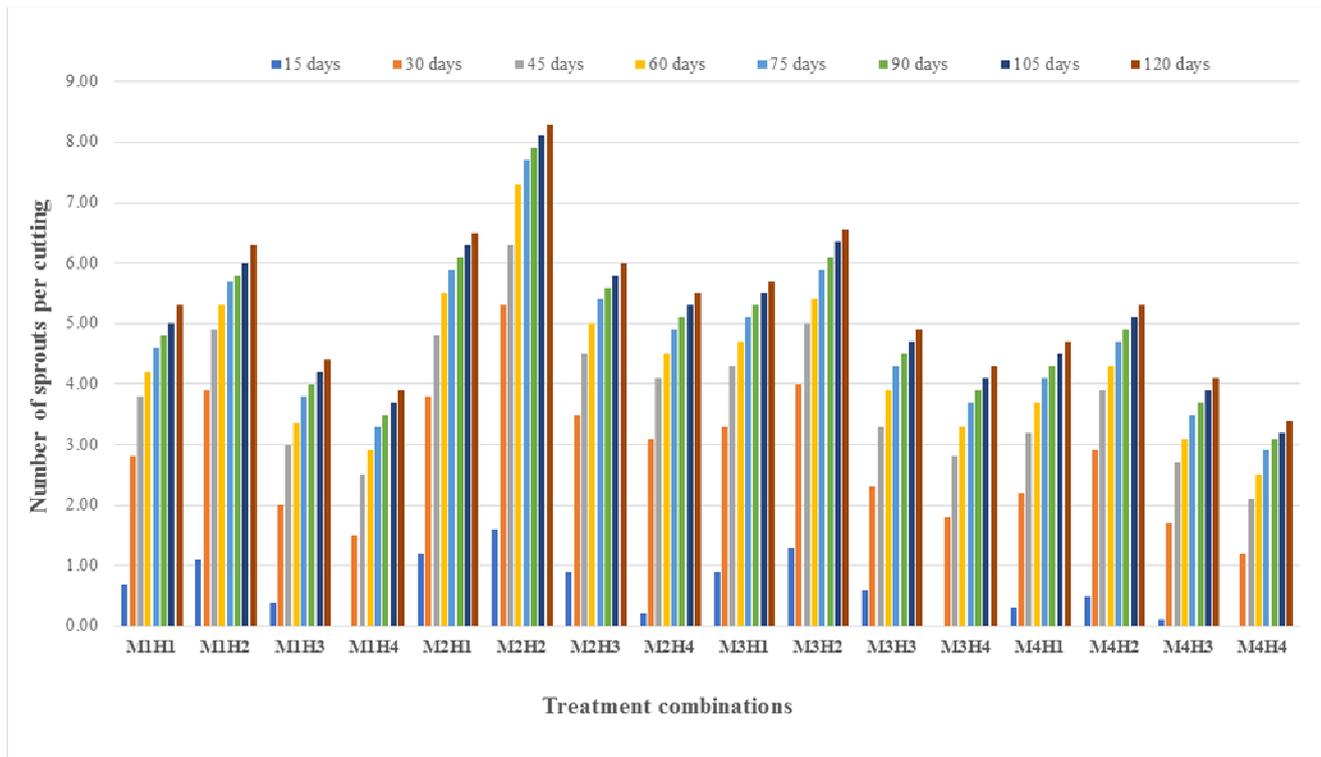


Figure 1 : Effect of rooting hormone and media on number of sprouts per cutting in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

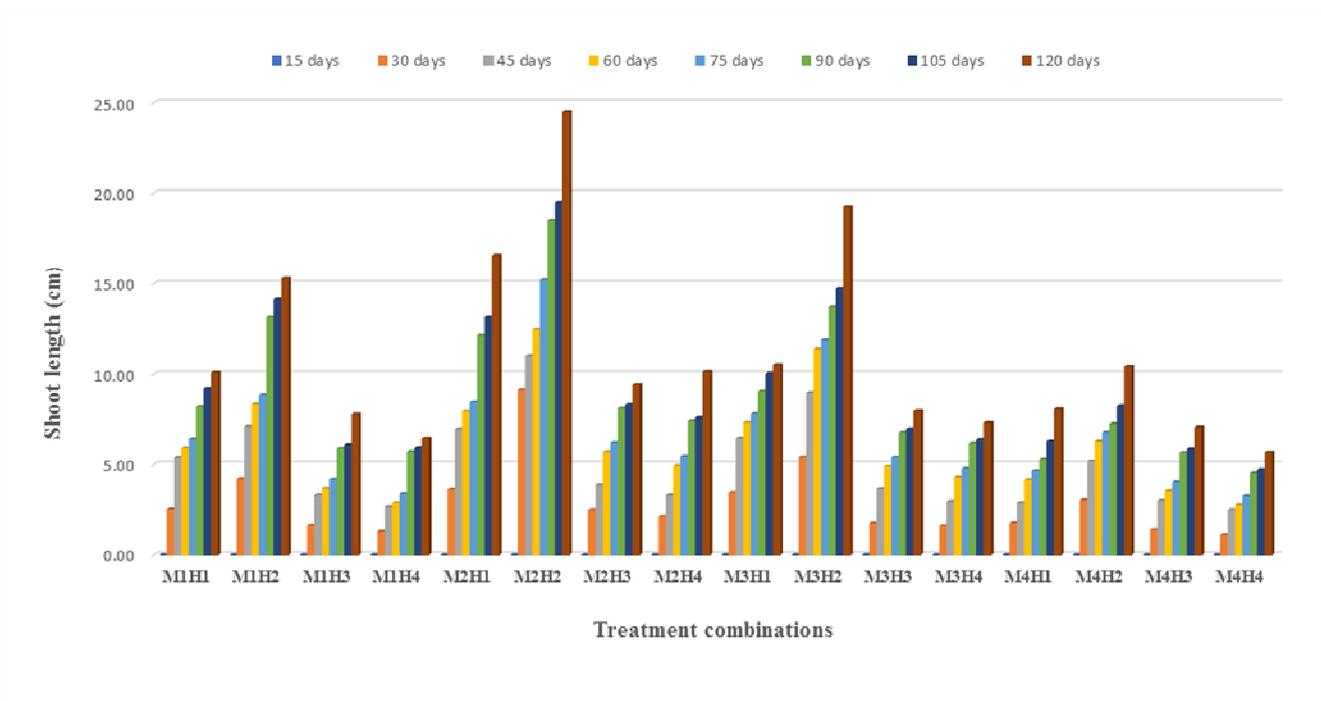


Figure 2 : Effect of rooting hormone and media on shoot length (cm) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

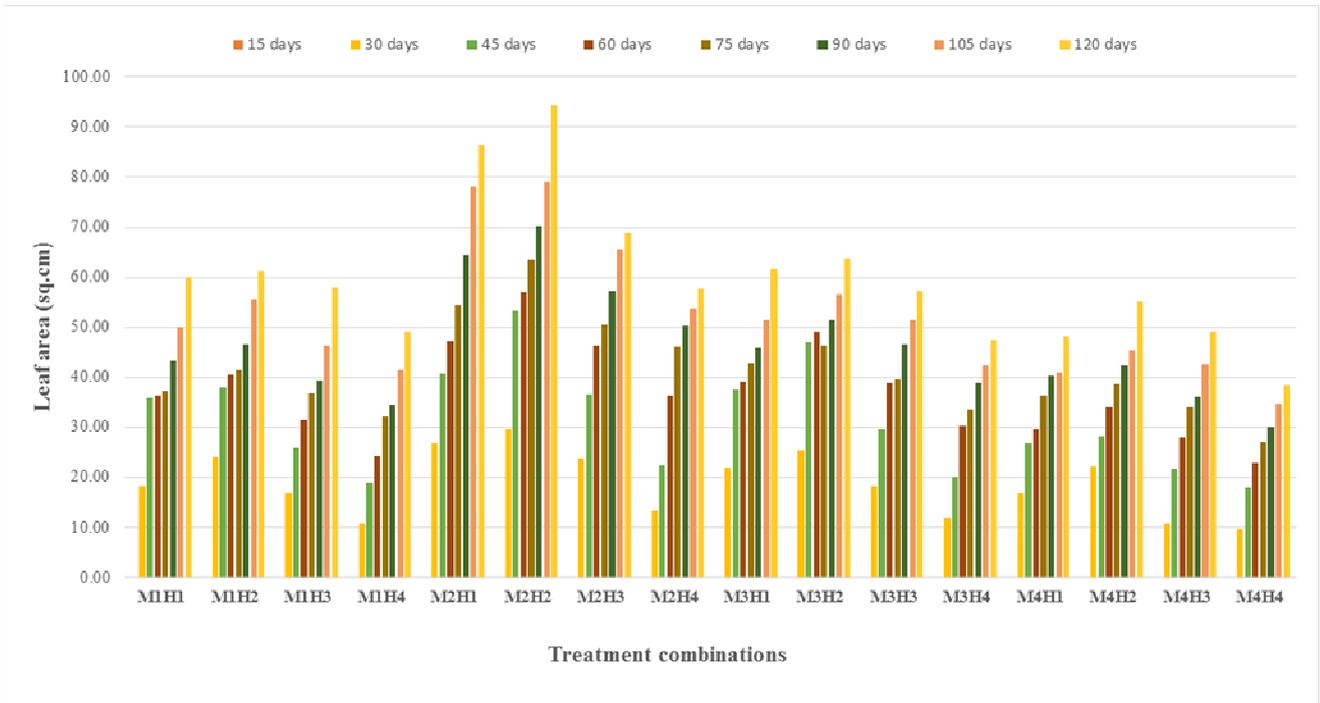


Figure 3 : Effect of rooting hormone and media on leaf area (sq.cm) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

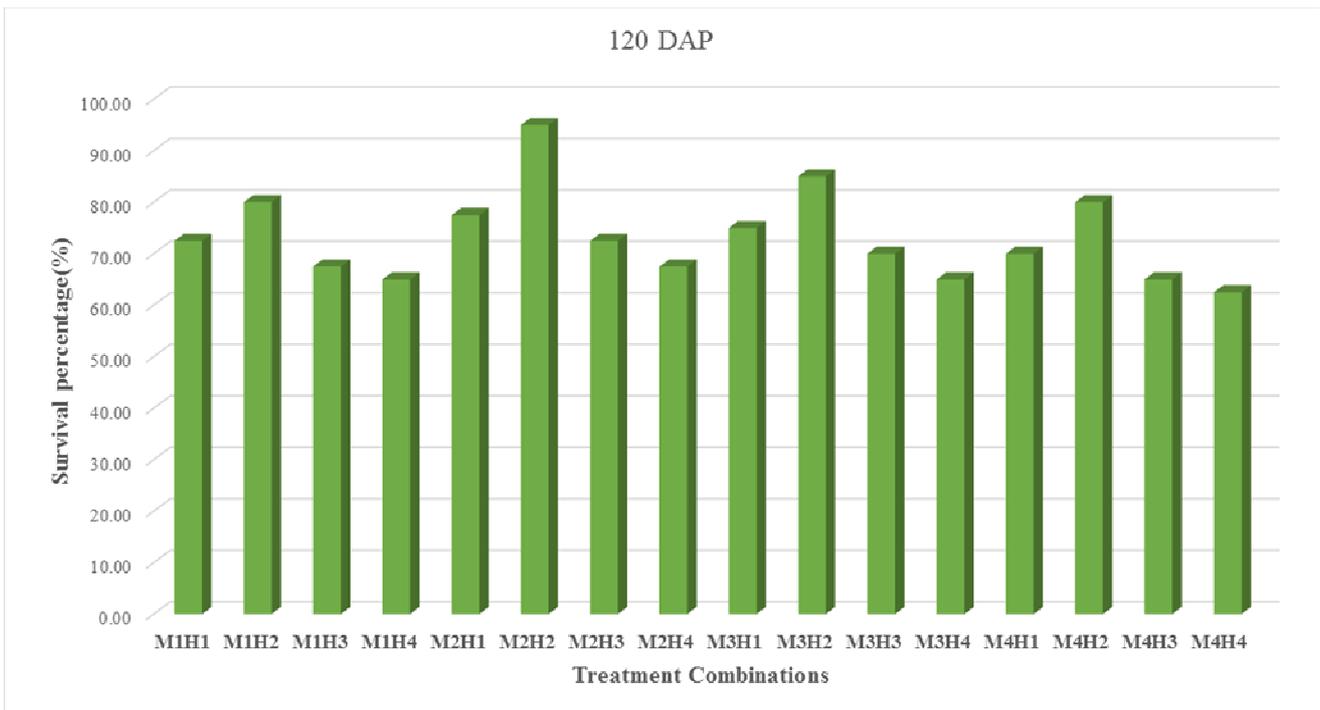


Figure 4 : Effect of rooting hormone and media on survival percentage (%) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

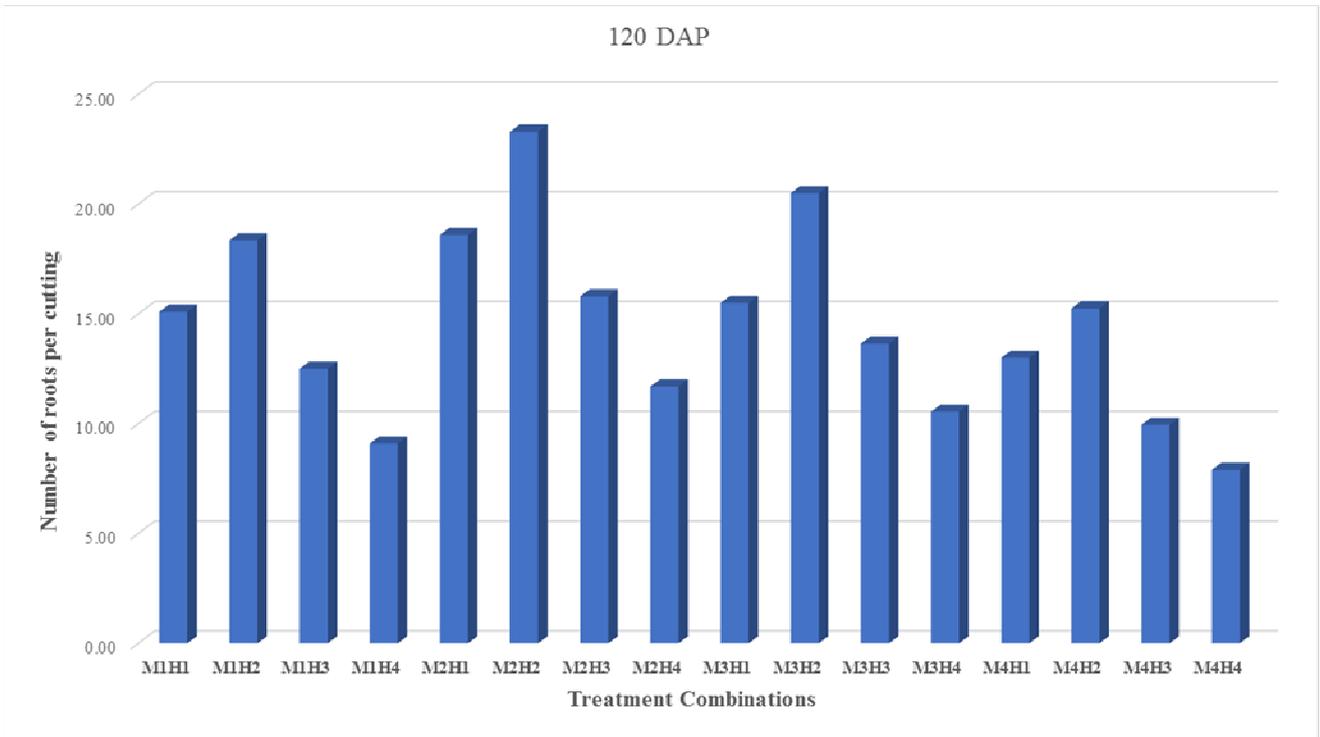


Figure 5 : Effect of rooting hormone and media on number of roots per cutting in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

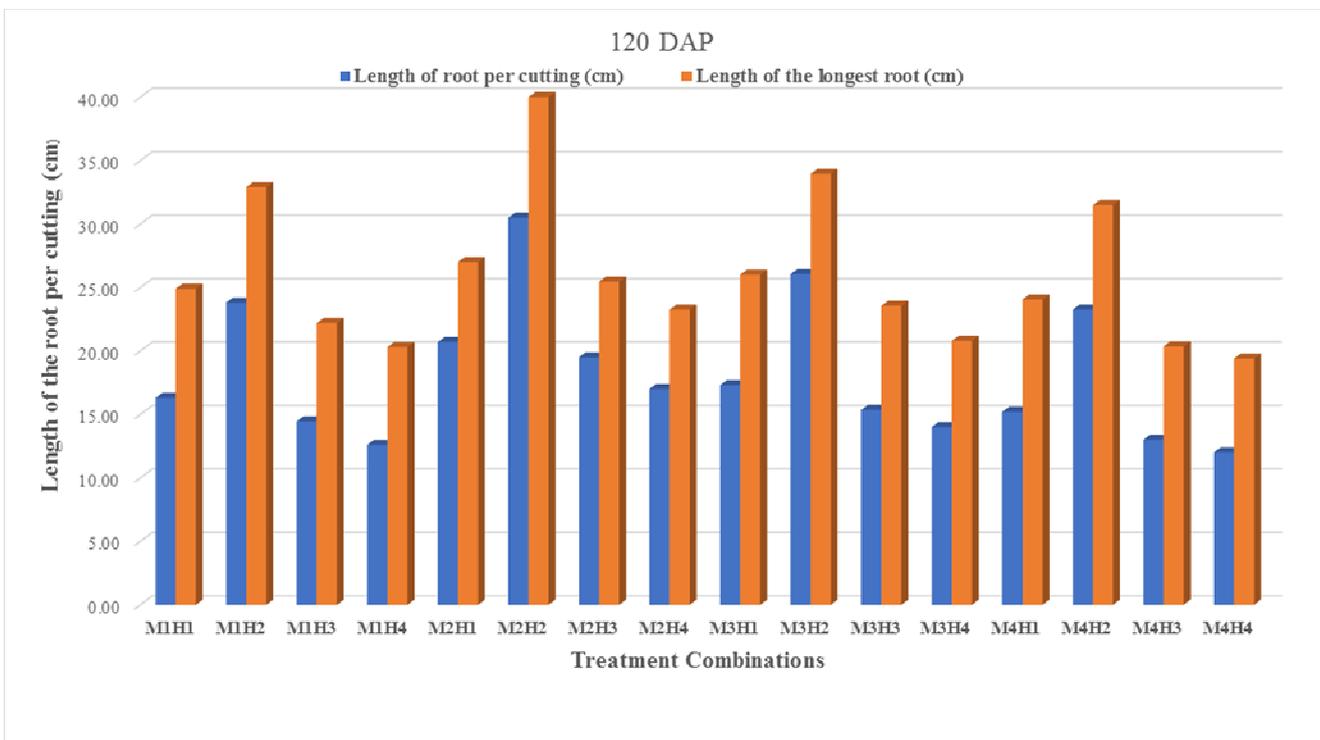


Figure 6 : Effect of rooting hormone and media on length of root per cutting (cm) and length of the longest root (cm) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].

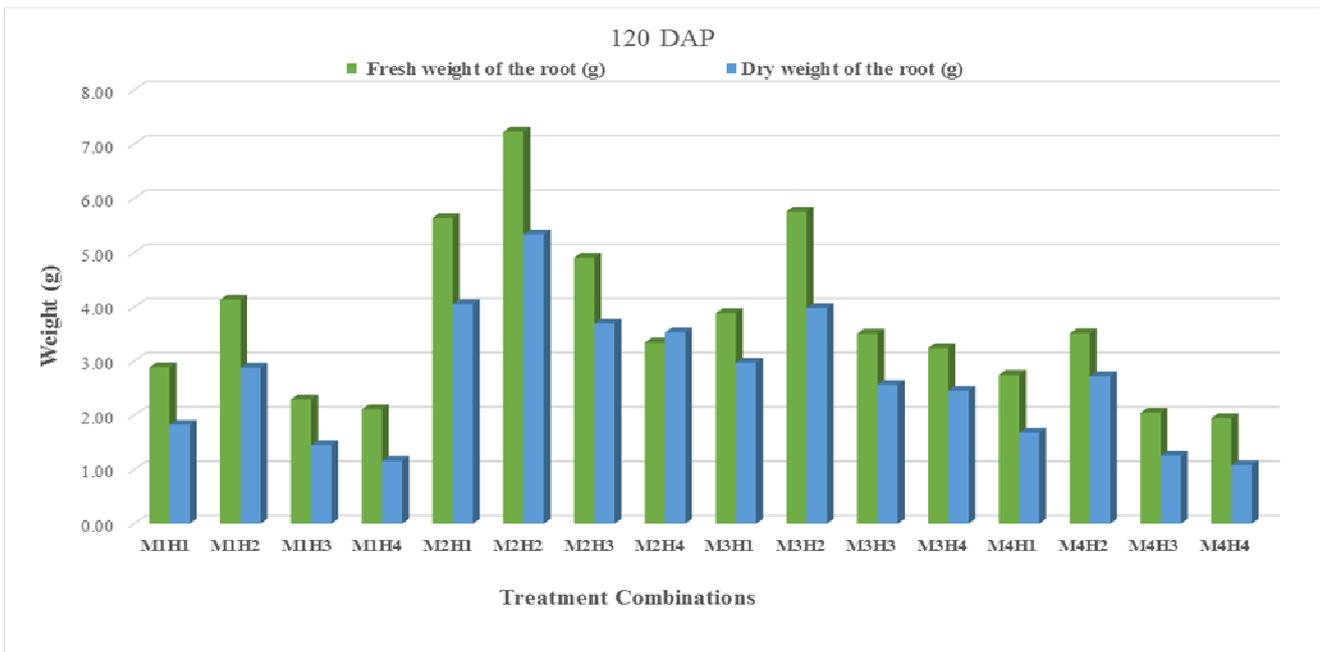


Figure 7 : Effect of rooting hormone and media on fresh weight and dry weight of the root (g) in hardwood cuttings of water apple [*Syzygium aqueum* (Brum. F. Alston)].



Plate 1 : Shoot growth of hardwood cuttings of water apple treated with different concentrations of rooting hormone (IBA) in media containing red earth + sand + cocopeat (2:1:1).



Plate 2 : Shoot growth of hardwood cuttings of water apple treated with different concentrations of rooting hormone (IBA) in media containing red earth + sand + vermicompost (2:1:1).



Plate 3 : Shoot growth of hardwood cuttings of water apple treated with different concentrations of rooting hormone (IBA) in media containing red earth + sand + vermicompost + cocopeat (2:1:1:1).



Plate 4 : Shoot growth of hardwood cuttings of water apple treated with different concentrations of rooting hormone (IBA) in media containing red earth + sand (2:1).

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