International Journal of Advanced Biochemistry Research 2025; SP-9(2): 513-518

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; SP-9(2): 513-518
www.biochemjournal.com
Received: 19-12-2024
Accepted: 22-01-2025

Rifat Bhat
Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Suja N Qureshi
KVK, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Sharbat Hussian
Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Kounser Javid
FAO, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Parveez A Sheikh
Division of Plant Pathology. Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Farooq A Ahanger
Division of Plant Pathology. Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Corresponding Author:
Rifat Bhat
Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Influence of organic manures and indole-3-butyric acid (IBA) on survival percentage of roots through improved mound layering methods of propagation in apple fruit

Rifat Bhat, Suja N Qureshi, Sharbat Hussian, Kounser Javid, Parveez A Sheikh and Farooq A Ahanger

DOI: https://doi.org/10.33545/26174693.2025.v9.i2Sg.3824

Abstract

The experiment on "Influence of Organic manures and IBA on survival percentage of roots through improved layering (Trench) methods of propagation in apple" were conducted at Fruit Nursery Shalimar SKUAST-K in the year 2022 and 2023. Data revealed percentage rooting sprouting and survival was significantly higher in apple root stocks propagated by trench layering improved method of vegetative propagation for rooting in M-7, M9T337 and MM-106. Four apple root-stocks varieties were planted with different treatment combinations IBA-0 ppm (Control) IBA-3000 ppm and IBA-5000 ppm) complete factorial randomized block design with 3 replications. Data revealed significant variability in rooting among root-stocks with variable characters in all. Organic manures in combination with IBA significantly raised higher rooting percent, root numbers and root length. In MM-106 showed best response in rooting percentage obtained with treatment combination of Soil cocopeat FYM + Vermicompost + IBA (5000 ppm) (45.5%) compared to 26.3% under control conditions. Howover M9-T337 root-stock organic manures also showed significantly higher rooting percentage from 52.7% under Soil + Cocopeat + FYM + Vermicompost + IBA (5000 ppm). The highest root length (19.9 cm) was recorded in M-7 treated with Soil + Cocopeat + FYM + Vermicompost + IBA 5000 ppm; while the shortest (9.2 cm) was in M9T337 when treated with control. There were substantial increases in root lengths of all the three root-stocks when treated with combination of Soil + Sawdust + Overoptimistic + IBA 3000. Accordingly the data revealed that trench layering treatment with combination of organic manures and IBA showed high improved rooting and survival of root-stocks in apple which could be a viable option and accessibility for farmer to develop quality planting root-stocks for high density planting at low cost for mass production of with objective of meeting commercially used root-stocks in apple

Keywords: Apple, clonal rootstocks, mound layering, organic manures

Introduction

Traditional Horticulture is replacing and dwarfing root stocks of apple has revolutionised apple fruit production and productivity emerged recently is used as a viable diversification option in agriculture. Horticulture crops provide nutritional security, generate employment, maintain ecological balance and provide raw material for agro processing industries as major share contributing to GDP of JK UT. In our Country temperate fruits are grown in more than ten states and U.Ts, but the quality production is in the Himalayan region only UT J&K has monopoly quality production covering 43.30 percent area and 80.18 percent production. Among the temperate fruits in J and K, apple ranks first, respectively. Still vast potential exists for both vertical and horizontal expansion. Yield of apple has shown an increase from 4.12 in 1975 to 13.07 M.T. per ha in 2019.Though it appears to be the highest among the apple producing states of the country, yet it is far below the level achieved by advanced countries where a production of 50-55 MT/ha. Jammu and Kashmir state enjoys unique and varied climate in the Indian subcontinent for successful production of temperate fruits particularly apple. In spite of the fact that J&K is the only state where yield of commercially important apple varieties is highest in the country yet it is not competent enough to produce the yields as obtained in advanced countries.

One of the main reasons of low productivity is the poor quality planting material and high standard Malling series which is considered main reason for higher production in European countries and seedling originated apple trees in Kashmir is secondary hurdle for low quality production. Large number of clonal root stocks which meet the demand of modern apple production for uniformity, tree size control, precocity, cropping efficiency, resistance to pests and diseases, adaptability to a wide range of soil and climatic conditions are now available. Apple trees grown on seedling root stocks of ten tend to develop into large and vigorous trees resulting in its difficult management (Marini *et al*., 2018) [21]. Clonal root stocks which offer a viable solution to this problem have been used by the fruit grower sin scientifically advanced countries for better management and quality fruit production. In most countries the reisan increasing interest for high density planting of temperate fruits in which precocious size controlling dwarfing and semi-dwarfing root stocks are used. Many physical and environmental factors such as climatic condition, root stock and scion vigour, training and pruning and orchard management are some of the other main considerations. Clonal Rootstocks like M9, M26, M4, M7, MM106 and MM111 are identified as competent roots for maximum fruit production per unit area in apple. However, clonal rootstocks have not found favour among the apple growers and they continue to propagate their plants on seedling rootstocks. The production/productivity of fruit crops particularly apple can be enhanced by shifting from traditional farming systems to hitech farming systems. The system involves the use of clonal rootstocks which have the quality attributes with size controlling features, prolific bearing characteristics, and uniformity in the produce. With the use of clonal rootstocks, the plant population ranging from 2222 to 3333 trees/ha can be accommodated which can result in increase of production by several folds. It clearly indicates that if an attempt is made in a coherent manner for the adoption of hi-tech farming system with the use of dwarfing clonal rootstocks, the productivity of fruit crops particularly apple can be enhanced at least 4 to 5 folds within the shortest possible time frame, as these clonal rootstocks behave precocious in their habit. With the large investment of money and management required to be successful, it is important to plan well and consider all details. Keeping all above points into consideration, the rootstocks of M7, M9T337, and MM106 through integration of Organic manure and IBA in mound layering could improve supply of affordable and quality apple planting materials and encourage farmers to venture in to commercial apple cultivation. This trial cum experiment was performed to determine influence of organic manures and indole-3-butyric (IBA) treatments on rooting, sprouting and survival characteristics of apple root stocks propagated by mound layering.

Materials and Methods

The Research experiment “influence of Organic manures and IBA on rooting and survival percentage of apple roots under mound layering method of propagation” was performed at fruit nursery area in the Division of pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar campus, Srinagar, Jammu & Kashmir during the years 2022 and 2023. Regarding materials and methods used during the trials at both years is mentioned below.

Location and climate

The Kashmir valley experiences temperate climatic conditions and the valley faces hardy winters from November to February when the temperature often drops below zero during which the valley is mostly covered with snow. The minimum and maximum temperature recorded during winters varies on average between-8 °C and 10 °C respectively. The valley is located at an altitude of about 1500-2500 meters above sea level (MSL) between 34°9’0” N latitude, 74°52’55” E longitude.

Experimental details

The treatments were applied in a CRD factorial with 12x2x3 treatment combinations. With 04 media levels, consisting of sand, soil, sawdust and cocopeat, 03 IBA treatment levels, (0, 3000 and 5000) ppm, 03 three replications and 02 rootstocks per replication (Table 1). Indole-3-butyric acid (IBA) was dissolved using distilled water to obtain two treatment concentrations namely, 3000 ppm and 5000 ppm. These IBA concentrations were used following recommendations of Srivastava *et al.* (2006) [25] that identified such concentrations as suitable for propagating difficult-to-root fruit trees such as apples. The sites oil with no application of organic manures and IBA hormones was considered as the control. Six months old apple rootstocks consisting of M 7, M9-T337, and MM 106 in the trench layering were selected, defoliated, bent and pegged into a trench (Fig. 1). The trenches were then covered with organic substrate mixtures and sites oil as the control then left to sprout and grow for three months. After three months, the organic substrates were removed and the sprouts were girdled by cutting a 1 cm ring around the sprout base, using as tain less-steel knife. Then IBA treatments namely, 0 (control), 3000 ppm, and 5000 ppm were applied to the girdle, using a paint brush (Fig.1). After application of IBA, sprouts were covered with the organic manure mixtures until harvesting at 6 weeks after hormone application. Individual sprouts were then harvested from the mother rootstocks in the layering nursery, defoliated, and then root pruned.

Table 1: Treatment combinations of Organic manures and IBA hormone concentrations used in the experiment to propagate apple root stocks under mound layering

Treatment no.	Organic manures combined with different levels of IBA concentrations
1	Control (soil)
2	Control (soil) + IBA (3000 ppm)
3	Control (soil) + IBA (5000 ppm)
4	Soil + Sand + FYM + IBA (0 ppm)
5	Soil + Sand + FYM + IBA (3000 ppm)
6	Soil + Sand + FYM + IBA (5000 ppm)
7	Soil + Sawdust + Vermi compost + IBA (0 ppm)
8	Soil + Sawdust + Vermi compost + IBA (3000 ppm)
9	Soil + Sawdust + Vermi compost + IBA (5000 ppm)
10	Soil + cocopeat + FYM + Vermi compost + IBA (0 ppm)
11	Soil + cocopeat + FYM + Vermi compost + IBA (3000 ppm)
12	Soil + cocopeat + FYM + Vermi compost + IBA (5000 ppm)

Statistical analysis: The observations recorded during the course of investigation were subjected to statistical analysis as per the method of "Analysis of Variance" (Fisher, 1950). The significance and non-significance of treatment effects were judged with the help of software OP Stat. The significant difference on the means was tested against the critical difference at 5% level.

Analysis of variance. The combined analysis of variance revealed significant (p<0.001) and n on significant (p>0.05) differences in response of the three root stocks (M 7, M9-T337 and MM106) to IBA and Organic manure treatments for all the traits *viz*., rooting characteristics, sprout length and survival rates(Table2).

Table 2: Estimates of means quares due to Organic manures and IBA treatment effects on rooting percentage, sprout length and survival of apple root stocks propagated by mound layering

Mean Squares						
Source of variation	**Df**	**Rooting percentage (%)**	**No. of roots**	**Root length**	**Shoot length**	**Survival rates**
Rootstocks	03	55.33***	64.25***	38.09***	75.17***	19.37***
IBA	02	0.91	8.02**	17.85***	6.11***	5.53**
Organic manures	05	6.18*	7.63***	6.38**	3.32***	0.89
Rootstocks*IBA	06	2.64**	0.39	0.72	0.88	4.98**
Rootstocks*Organic manures	15	8.46***	6.08**	0.22	0.57	3.57
IBA*Organic manures	10	10.0***	5.48***	8.22***	0.97**	3.3***
Rootstocks*IBA*Organic manures	30	3.88***	7.02***	6.58***	0.87*	2.25

IBA = Indole-3-butyric acid,*, **, and *** = significant at 0.05, 0.01 and, <0.001 level respectively
Control = Site soil + IBA; IBA= Indole-3-butyric acid (3000 & 5000 ppm); M-7, M9-T-337 & MM-106 (Clonal apple rootstocks) organic manures: soil + sand + FYM + IBA, soil + sawdust + vermicompost + IBA, soil + cocopeat + FYM + vermicompost + IBA

Table 3: Impact of treatment combinations on rootstock growth and development.

Rootstocks	Treatments	Rooting rate (%)	Root numbers	Root length (cm)	Sprout Length (cm)	Survival rate (%)
M-7	Control (soil)	13.4	7.2	10.2	20	18.8
	Control (soil) + IBA (3000 ppm)	23.3	16.4	12.3	24.2	34.2
	Control (soil) + IBA (5000 ppm)	25.7	17.5	15.2	32.4	35.6
	Soil + Sand + FYM + IBA (0 ppm)	17.9	11.9	11.3	22.3	28.3
	Soil + Sand + FYM + IBA (3000 ppm)	26.1	20.9	15.2	32.7	38.3
	Soil + Sand + FYM + IBA (5000 ppm)	42.2	24.5	15.9	35.7	42.5
	Soil + Sawdust + Vermi compost + IBA (0 ppm)	22.1	14.7	11.3	22.8	29.6
	Soil + Sawdust + Vermi compost + IBA (3000 ppm)	30.8	23.8	15.3	34.1	39.1
	Soil + Sawdust + Vermi compost + IBA (5000 ppm)	44.1	25.5	16.3	36.1	56.7
	Soil + cocopeat + FYM + Vermi compost + IBA (0 ppm)	22.9	14.8	12.1	23.4	32.8
	Soil + cocopeat + FYM + Vermi compost + IBA (3000 ppm)	33.4	24.4	15.8	34.4	39.5
	Soil + cocopeat + FYM + Vermi compost + IBA (5000 ppm)	46.4	27.3	19.9	39.3	58.3
M9-T337	Control (soil)	15.8	9.7	9.2	30.8	20.3
	Control (soil) + IBA (3000 ppm)	26.3	16.2	11.2	38.2	34.2
	Control (soil) + IBA (5000 ppm)	34.3	18.7	11.5	40.2	35.6
	Soil + Sand + FYM + IBA (0 ppm)	22.1	11.9	9.8	32.5	28.3
	Soil + Sand + FYM + IBA (3000 ppm)	39.8	20.9	11.6	52.2	38.3
	Soil + Sand + FYM + IBA (5000 ppm)	45.9	24.5	13.9	61.3	45.5
	Soil + Sawdust + Vermi compost + IBA (0 ppm)	24.4	14.7	9.8	34.2	29.6
	Soil + Sawdust + Vermi compost + IBA (3000 ppm)	41.9	23.8	12.8	55.3	42.9
	Soil + Sawdust + Vermi compost + IBA (5000 ppm)	52.1	25.5	14.1	64.6	54.5
	Soil + cocopeat + FYM + Vermi compost + IBA (0 ppm)	25.9	14.8	10.5	36.5	32.8
	Soil + cocopeat + FYM + Vermi compost + IBA (3000 ppm)	42.1	24.4	13.7	58.5	43.5
	Soil + cocopeat + FYM + Vermi compost + IBA (5000 ppm)	52.7	28.5	15.4	65.5	56.4
MM-106	Control (soil)	11	7.2	9.3	20	18.8
	Control (soil) + IBA (3000 ppm)	19.4	12	12.3	24.2	33.7
	Control (soil) + IBA (5000 ppm)	20.2	12.8	14.8	31.1	34.6
	Soil + Sand + FYM + IBA (0 ppm)	15.9	9.6	11.3	22.3	25.2
	Soil + Sand + FYM + IBA (3000 ppm)	21	12.8	14.8	32.6	37.3
	Soil + Sand + FYM + IBA (5000 ppm)	24.5	17.2	15.9	35.7	42.5
	Soil + Sawdust + Vermi compost + IBA (0 ppm)	16.5	10	11.3	22.8	27.4
	Soil + Sawdust + Vermi compost + IBA (3000 ppm)	16.5	13.3	15.1	34.1	39.1
	Soil + Sawdust + Vermi compost + IBA (5000 ppm)	35.6	20.3	15.9	36.1	54.2
	Soil + cocopeat + FYM + Vermi compost + IBA (0 ppm)	18	11.1	12.1	23.4	31
	Soil + cocopeat + FYM + Vermi compost + IBA (3000 ppm)	21.4	13.7	15.4	34.4	39.5
	Soil + cocopeat + FYM + Vermi compost + IBA (5000 ppm)	45.5	21.3	17.8	39.3	55.7

Table 4: Logistic regression analysis for the effect of rooting, root numbers, root length, IBA and Organic manures on survivability of apple root stocks propagated by mound layering

Factors	Coefficient ± se	Odds ratio	Sig. (P value)
No of Roots	0.008±0.014	2.006	0.814ns
Rooting	0.900±0.587	3.014	0.091*
Sprout length	0.040±0.009	2.02	0.004**
Root length	-0.049±0.026	0.992	0.41
Organic manures			
Sand	0.019±0.470	1.017	0.99ns
FYM	0.230±0.480	2.120	0.64
Vermicompost	0.250±0.480	2.130	0.53
Sawdust	0.180±0.480	1.197	0.72ns
Cocopeat	0.170±0.480	1.180	0.81
Hormone Concentration (ppm)			
3000 ppm	0.946±0.399	3.331	0.007**
5000 ppm	0.078±0.354	2.07	0.99ns

*,**= significant at $p<0.05$ & $p<0.01$ respectively; ns= non-significant; sig.= significance level

Results

Influence of organic manures and indole butyric acid on rooting percentage

The use of Organic manures in mound layering had significantly effected on rooting percentage, root numbers, root length and sprout length of root stocks (Table 2). From the results of multiple comparisons, the best response in rooting percentage was obtained in MM 106 root stock treated with Soil + Sawdust + Vermicompost + IBA (0 ppm) (52.7%) compared to 26.3% under control conditions (Table 3). Rooting percentages increased by two times in rootstock MM106 when treated with Soil + Sawdust + Vermicompost + IBA (0 ppm) and Soil + Cocopeat + FYM + Vermicompost + IBA (3000 ppm) to 52.1%and 25.9% respectively as compared to the control conditions (sitesoil) where rooting was at 26.3% (Table4). In M9-T337 root stock, organic manures increased rooting percentage from 25.7% under control conditions to 46.4% but reduced to 30.8% under Soil + Cocopeat + FYM + Vermicompost + IBA (3000 ppm)

Influence of Organic manures and IBA on sprout length and survivability

The treatment organic manures were significant ($p<0.01$) on sprout length however in significant on the survival rates of apple rootstocks. The effect of IBA was significant ($p<0.01$) for both sprout length and survival rates of apple root stocks (Table 2). Generally, growth length was high ranging from a minimum of 20.0 cm in M9T337 variant when treated with IBA 0 ppm to the maximum sprout length of 65.5 cm observed in MM-106 treated with a combination of Soil + Sawdust + FYM + Vermicompost + IBA-3000 ppm (Table 3). The use of organic manures viz treatment combination of Soil + Sawdust + Vermi compost increased sprout lengths in MM106 (65.6 cm), M7 (43.3 cm) and M9-T337 (39.3 cm). Hormone treatments with IBA3000 ppm and IBA5000 ppm had an inhibitory effect one longation of sprouts resulting in shorter sprouts compared to the control. The interaction between organic manures and IBA increased sprout length in MM106 with the highest effect recorded for Soil + Sawdust + Vermicompost + IBA-3000 pp mat 65.5 cm. Survival rates varied significantly across treatments and interaction effects (Table 2). Significant effects were observed for IBA ($p<0.01$), Root stocks + IBA ($p<0.01$), and IBA + organic manures ($p<0.001$) interactions. Survival rates of apple rootstocks increased with both Soil + Sawdust + Vermicompost and Soil + Cocopeat + FYM + Vermicompost treatments except in M7 where Soil + Cocopeat + FYM + Vermicompost Reduce Surviv ability from 29.6% under control conditions to 28.3% (Table 4). High survival rates were obtained under IBA 3000 ppm in M9T337 and M7 at 51.7 and 49.5%, respectively while the survival rate in MM106 was 52.4% under Soil + Sawdust + Vermicompost + IBA-3000 ppm. (Table3). Similarly, root length varied significantly ($p<0.01$) with the concentration of IBA and the type of organic manures across the three apple rootstocks (Table 2). The highest root length (19.9 cm) was recorded in MM106 treated with Soil + Sawdust + Vermicompost + IBA 3000 ppm; while the shortest 9.2 cm) was in M9T337 when treated Soil + Sand + FYM + IBA-3000 ppm. There were substantial increases in root lengths of all the three rootstocks when treated with Soil + Sawdust + Vermicompost + IBA 3000 ppm but the alternative resulted in reduced root length in all rootstocks except in M9T337. Both IBA-3000 and IBA-5000 ppm negatively affected root lengths across the three apple root stocks compared to the control and the interaction effects between organic manures and IBA resulted in reduced root lengths despite being significant in Table1.

Discussion

Variability of root, sprout and survival characteristics

The significant ($p<0.01$) variability among the three apple root stocks in response to organic manures and IBA treatments (Table2), suggests potential for selection and production of quality apple clonal rootstocks. Differences in rooting characteristics among the root stock genotypes might be due to variation in endogenous auxin levels and the inherent genetic characteristics of genotypes.M7 and MM106 are semi-dwarfing clonal root stocks and M9T2337 is dwarfing rootstock, this could explain the observed differences between the different rootstocks (Table 2 and Table 3). The significant interaction between apple rootstocks and organic manures for rooting percentage and root numbers (Table2) suggests variability in the response of apple root stock genotypes to organic manures and IBA concentrations compared to individual treatments.

Effect of Organic manures on root characteristics

The results revealed that organic manures significantly influenced growth of roots through higher root numbers and root length of apple root stocks propagated by mound layering mound layering (Table 3). Both root numbers and root length increased probably due to fertility of soil increased due to rich organic content as improved soil structure, water holding capacity, drainage, and aeration which enhances gaseous exchange between roots and the atmosphere thus promoting adventitious root growth. The use of organic manures has been reported in propagation studies of several rootstocks with positive effects on rooting, shooting, and survival (Galavi *et al.*, 2013; Shabani *et al.*, 2015; Ari, 2016) [16, 23, 1]. According to Nia *et al.* (2015) [22], culture media involving manure, soil, peat, tea wastes and rice husks have significant effects on cation exchange capacity and soil pH, aeration and water retention capacity of soils which improves the absorption of nutritional elements. Organic manures serves as a reservoir for nutrients, provide anchorage for root stock roots and modifies soil texture leading to improved nutrient availability and nutrient flow and enhanced absorption by the roots. According to Yaseen *et al*. (2009) [11], organic manures enhance availability of metabolic substrates which support the high-energy processes of root initiation and growth. However, both organic manures in this study resulted in lower rooting percentage sin M7 root stock compared to the control (site soil) (Table 3). This suggests that root initiation and growth in M7 rootstock could have been negatively affected by water soluble phenolic compounds found inorganic manures. This argument is supported by Ma and Nichols (2004) [20], who reported that organic manures contain high cellulose and lignin contents and insufficient nitrogen supplies which could severely restrict root initiation and growth.

Effect of IBA on the rooting characteristics of apple root stocks

The current results revealed that IBA treatment increased root length, sprout length and survival of rootstocks (Table 3). The ability of synthetic auxins such as IBA to promote rooting during propagation of fruit trees such as apples is widely reported (Doric *et al.*, 2014; Sharma *et al.*, 2007; Khatik and Sharma, 2013) [13, 24, 18]. Krieken *et al*. (1993) [19] while studying the root regeneration of stem slices of apple shoots; observed that application of exogenous IBA enhances rooting through increased internal-free IBA, which synergistically modifies synthesis and action of endogenous IAA and enhances tissues sensitivity to endogenous IAA. Present experiment conducted revealed significant effect of IBA on rooting, root length and survival of apple root stocks might have been enhanced by wounding cum girdling of the sprouts at the root collar and applying IBA to the girdle. These results in agreement with findings of Taizand Zeiger (2002) [26] who reported that rooting can be enhanced in a layering system, by girdling or wounding the stem to cause accumulation of carbohydrates and auxins above the girdled area, as the downward movements of these compounds are blocked by the girdle. According to Hartmann *et al.* (1997) [17], the girdling of the sclerenchyma/lignified tissue enhance absorption of the applied plant growth regulators and stimulate root initiation.

The results further revealed that IBA3000 ppm gave the highest rooting response in, MM106, M9T337 and M7 apple root stocks. Such high hormone concentrations are recommended for propagating hard-to-root species such as apples (Srivastava *et al.*, 2006) [25]. Khatik and Sharma (2013) [18] reported IBA2500 ppm as the best treatment for inducing better root system in apple clonal rootstock-Merton 793, in terms of rooting percentage, number of roots, total root length and root to shoot ratio. So IBA3000 ppm can be considered optimum for propagation of apple rootstocks under trench layering that gives the best rooting and survival characteristics.

Combined effect of IBA and Organic manures on root characteristics

The combination of IBA and Organic manures resulted in significant increase in the number of roots, root length, and rooting percentage (Table 3). These results suggest that combined use of Organic manures and IBA stimulates root initiation better than control. This indicates that mixing of Organic manures and IBA has positive effects on rooting characteristics of apple root stocks propagated by trench layering. Similar observations were reported by Ercisli *et al.* (2002) [14] while studying the propagation of kiwi fruit. The combined effects of organic manures and IBA concentrations, cutting time and rooting media significantly influenced rooting percentage, root length and root numbers of hard wood cuttings better than any single treatment.

Conclusion

The results generally indicate that using IBA both at 0 ppm and 3000 ppm, and the organic manures promoted rooting, root numbers, root length, sprout length and survival of apple root stocks in various ways enhancing potentiality for rapid propagation under trench layering. Treatment T-8 is the best organic manure combination for enhanced trench layering of apple rootstocks like M7,M9T337 and MM106 giving the highest number of roots and longest root length while Treatment T-11is the best substrate for propagation of MM106.Rooting, sprout length and IBA 3000 ppm significantly improves survivability of apple rootstocks.

References

1. Ari E. Effects of different substrates and IBA concentrations on adventitious rooting of native *Vitex agnus-castus* L. cuttings. Acta Sci Pol Hortic Cultus. 2016;15(2):27-41.
2. Baro J, Vinayaka KS, Chaturvedani AK, Rout S, Sheikh IA, Waghmare GH. Probiotics and Prebiotics: The Power of Beneficial Microbes for Health and Wellness. Microbiol Arch Int J. 2019;1(1):1-7. DOI: https://doi.org/10.51470/MA.2019.1.1.1.
3. Ausari PK, Gharate PS, Saikanth DRK, Devi OB, Bahadur R, Singh YS. High-tech farming techniques in fruit crops to secure food demand: A review. Int J Environ Clim Change. 2023;13(11):2716-2730.
4. Sultana N, Saini PK, Kiran SR, Kanaka S. Exploring the antioxidant potential of medicinal plant species: A comprehensive review. J Plant Biota. 2023;2:9-13.
5. Gupta S, Kotyal K, Beleri PS, Langangmeilu G, Malathi G. Advancing nature-based solutions for climate adaptation and ecosystem restoration. Environ Rep Int J. 2019;1(2):8-12. DOI: https://doi.org/10.51470/ER.2019.1.2.08.
6. Alemu TT. Effect of storage time and room temperature on physicochemical and geometric properties of banana (*Musa* spp.) fruit. J Plant Biota. 2023;2:30-40.
7. Rajesh GM, Gomadhi G, Malathi G, Nehul JN, Krishnaveni A. Innovative pathways in environmental monitoring and advanced technologies for sustainable resource management. Environ Rep Int J. 2019;1(1):17-20. DOI: https://doi.org/10.51470/ER.2019.1.1.17.
8. Bashir A, Ganai NA, Qayoom S, Yousuf MW. Influence of clonal rootstocks on major morphological characteristics of some exotic apple cultivars in Northern Himalayas of Kashmir Valley. Biol Forum Int J. 2023;15(5a):1-5.
9. Myster RW. Tree families and physical structure across an elevational gradient in a Southern Andean cloud forest in Ecuador. J Plant Biota. 2024;2:1-9.
10. Rithesh L. Defense mechanisms and disease resistance in plant-pathogen interactions. Plant Sci Arch. 2020;5(4):1-4. DOI: https://doi.org/10.51470/PSA.2020.5.4.01.

11. Been TJ, Mir MA, Malik AR, Yaseen I, Mir M, Mushtaq R. Recent advances in varietal improvement and rootstock breeding. Apples. 2022:25-43.
12. Yusuf AA, Anmol, Tripathi A, Khan S, Nautiyal P, Lakineni PK, *et al*. Emerging trends and innovations in artificial intelligence and data science technologies. J e-Sci Lett. 2024;5(1):20-26.
DOI: https://doi.org/10.51470/eSL.2024.5.1.20.
13. Doric D, Ognjanov V, Ljubojevic M, Barac G, Dulic J, Pranjic A, *et al*. Rapid propagation of sweet and sour cherry rootstocks. Not Bot Horti Agrobot Cluj-Napoca. 2014;42(2):488-94. DOI: 10.15835/nbha.42.2.9671.
14. Ercisli S, Anapali Ö, Esitken A, Sahin Ü. The effects of IBA, rooting media, and cutting collection time on rooting of kiwifruit. Gartenbauwissenschaft. 2002;67(1):34-38.
15. Ghutke TD, Kadam RG, Vineeth M. Impact of organic additives on enzymatic antioxidant activities in *Lentinus edodes* shiitake mushroom. Environ Rep Int J. 2023;5(1):13-6.
DOI: https://doi.org/10.51470/ER.2023.5.1.13.
16. Galavi M, Karimian MA, Mousavi SR. Effects of different auxin (IBA) concentrations and planting-beds on rooting grape cuttings (*Vitis vinifera*). Ann Rev Res Biol. 2013;3(4):517-523.
17. Hartmann HT, Kester DE, Davis J, Geneve RL. Plant propagation: Principles and practices. Northeastern USA: Prentice-Hall; 1997.
18. Khatik P, Sharma D. Effect of IBA and NAA on stool layering in apple clonal rootstock Merton 793. Prog Hortic. 2013;45(2):388-391.
19. Krieken WM, Breteler H, Visser MH, Mavridou D. The role of the conversion of IBA into IAA on root regeneration in apple: Introduction of a test system. Plant Cell Rep. 1993;12(4):203-206.
20. Ma YB, Nichols DG. Phytotoxicity and detoxification of fresh coir dust and coconut shell. Commun Soil Sci Plant Anal. 2004;35(12):205-218.
21. Mushtaq R, Pandit A, Ali MT, Raja RHS, Sharma MK, Nazir N, *et al*. Phenological features of four exotic apple cultivars on M9T337 rootstock under high density plantation in North Himalayan region of India. Curr J Appl Sci Technol. 2018;29(6):1-5.
22. Nia AF, Sardrodi AF, Habibi MM, Bahman S. Morphological and physiological changes of aloe (*Aloe barbadensis Miller*) in response to culture media. Int J Agron Agric Res. 2015;6(6):100-5.
23. Shabani Z, Moghadam EG, Abedi B, Tehranifar A. Effect of media and regulators of plant growth on micropropagation of Myrobalan 29 C rootstock. J Hortic For. 2015;7(3):57-64.
24. Sharma T, Modgil M, Thakur M. Factors affecting induction and development of *in vitro* rooting in apple rootstocks. Indian J Exp Biol. 2007;45(9):824-829.
25. Srivastava A, Bartol KM, Locke EA. Empowering leadership in management teams: Effects on knowledge sharing, efficacy, and performance. Academy of management journal. 2006 Dec 1;49(6):1239-1251.
26. Taiz L, Zeiger E. Photosynthesis: physiological and ecological considerations. Plant Physiol. 2002;9:172-174.