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RESEARCH ARTICLE
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EFFECT OF INDOLE BUTYRIC ACID (IBA) ON *GINKGO BILOBA* L. CUTTINGS BY USING QARSHI NUTRI COMPOST AT QARSHI BOTANICAL GARDEN HATTAR, HARIPUR KPK, PAKISTAN

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ABSTRACT

The effect of Indole butaric acid (IBA) on vegetative propagation of *Ginkgo biloba* stem cutting was studied under climatic conditions of district Haripur. The propagation of this plant species is very important to reduce the threats to its extinction, because it's the only living fossil in the world. Herein, we investigated the effect of IBA on the different types of stem cuttings of Ginkgo biloba at various hormonal concentrations. Three types of cuttings were used in the study viz, soft wood, hardwood and semi hard wood. Cuttings were grouped as semi-hardwood (current season's growth but fairly matured), hardwood (more than a year old) and softwood (tender growing stems) based on their physiological ages. Three different treatments (T1, T2, T3) of IBA, (300 µM, 600 µM and 900 µM) was applied to each cutting. For each type of cutting one control group was used for comparing the treatment response on root and shooting parameter. In the month of January, the minimum low temperature was recorded as 5˚C. Similarly, in June the high temperature was recorded as 36˚C. Similarly, the minimum humidity (33.4 %) was recorded for the month of June whereas; maximum 65.7% humidity was recorded for the month of February, 2018. Semi hardwood cutting took less time (17 days) in sprouting at 600 µM concentrations of IBA and 18 days at 900 µM. The data shows that 600 µM IBA was best for the performance of morphological parameter of shoot followed by 900 µM concentrations. It was observed that significant results in root development and morphogenesis of shoot parameter in all type of cuttings. It was recorded that increasing the concentration of IBA from 300 µM to 600 µM, the rooting efficiency and subsequent morphological parameters of the shoot significantly increases, however, increasing the concentration further up to 900 µM. We found no major difference in the efficiency of rooting and morphological parameters of the shoot. Furthermore, it was noticed that in semi hardwood cutting, IBA at 600 µM show high rooting efficiency as compared to hardwood and softwood cuttings. VIII Overall, the result of this investigation shows that semi hardwood cutting are efficient for the propagation of this plant and commercial exploitation.

Keywords: *Ginkgo Biloba,* Qarshi Botanical Garden, Indole Butyric Acid (IBA), Nutri Compost

INTRODUCTION

Ginkgo Biloba also called “Maiden Hair Tree” for the reason because it has fan shaped leaves is a living fossil since it is the only the living species of the order Ginkgoales that used in exist on earth over past few decades when the dinosaurs roamed the planet that makes period of about more than 200 million years ago. The leaves were divided in two well defined lobes giving it the species name of “Biloba”. The *Ginkgo* tree was from one of species of plants that regenerated actively after Hiroshima atomic bomb blast in 1945. At least until 1993, a specimen remained in the Shukukein garden that’s about 1,400 meters far from the hypocenter of the blast (Kiefer et al. 2004)

Ginkgo biloba is a living fossil and is native to China and Japan. It was found in many countries of the world although faced extinction in Ice Age period. Specie can now be found wildly only in China but cultivated in many other countries of the world (Bidak et al. 2022; Lee et al. 2021).

Ginkgo biloba is one of the medium-large deciduous trees with specimens over 50m with normal approximate height of 20-30 meters. It belongs to family Ginkgoaceae of the order Ginkgoales. It is a deep-rooted tree with uncertain branches that is long as well as have angular crown. Growth of ginkgo branches occur in length along with growing roots and regular spaced leaves helping the appearance of spur shoots. The seed about is 1.5 to 2.0 cm long with yellow brown soft and fruity outer layer. Both male and female produced separate flower on their own plants (Li et al. 2022).

A pre-angiosperm strategy can be represented possibly on *Ginkgo* genus due to its slow evolutionary rate for its abnormal environments at streamside. *Ginkgo* expanded in well-known flowering era in which ferns and cycadeoids were dominated over the streamside environments resulting formation of low canopies (DiMichele et al. 2008). Some habits of *Ginkgo* can be reason of its adjustment to this kind of environment like its property of having extensive seeds and gobble production convention of side branches to approximate height of 10 meters pre-elongation process (Zhang et al. 2015).

In modern days *Ginkgo biloba* grows in watery as well as drained places while ginkgo also has same nature. The grouts record at the most of fossil Ginkgo localities specified that its growth in disturbed places can also be possible primarily also along the streams and leaves (Qian et al. 2017). *Ginkgo* presents an "ecological paradox" due to the reason of its favorable traits for living in clone reproduction environment other life history traits behave reversely to those evinced through contemporary plants thriving in distraught surrounding Steady growth or production, gigantic seeds, delayed maturity (Singh et al. 2021).

It is of high medicinal value plant and is commercially cultivated in France and United States of America. Worldwide total sale of *Ginkgo* is nearly 600 million US dollars. It has now been cultivated worldwide along the urban street and for the production of its eatable nuts and medicinally active leaves (Brinckmann et al. 2022). Ginkgo seeds are used to relieve rasping as well as to lessen phlegm. For asthma patients *Ginkgo* leaves are said to be of great benefit mostly used in dried leaves form that is also a healthy choice for lungs and heart. It also has consequences of strengthening the lungs or diminishes asthma also helpful in severe appalling cough conditions. It is also used for reducing pain used for obstruction in chest and pericardial pain. It has many ostensible but no tropic properties (Shahrajabian et al. 2022). It is mainly used as source of improving the long-lasting memory and can act as an anti-vertigo agent. The extract of this plant is used in aliment for many diseases and as a supplement for helping in improving blood flow to various organs and tissues, also provides protection against nitrogen oxide free radicals impaired cells as well as blocks the effects of platelet aggregation and blood clotting that have been usually related to onset of many abnormalities. It can also help in cardiovascular, renal and CNS disorders. Previous researches have proved this as a helpful material for improving memory, headache relief, ringing ears and depression (Miraj et al. 2016).

Due to harvesting of *Ginkgo biloba* on large scale it has been listed as rare species in 1997 by IUCN. Efforts are required for conservation of this lively fossil tree. Countries like China, Europe, France and Germany have taken positive steps on high scale propagation of this plant for its conservation and distribution in nature. But despite of its medicinal importance the ornamental value of this specie still hasn’t caught much attention particularly in Pakistan (Rimkiene et al. 2021).

Ginkgo trees start bearing seeds at age of 30 to 40 years. It has a dioecious characteristic with separate sexes. Male plants produce small pollen cones while females don't. Female is 1.5–2 cm long with light yellow brown fleshy outer layer (the sarcotesta) soft and fruit-like and is attractive in appearance but contains butyric acid (also known as butanoic acid) and after being fallen it feels like smell of foul butter or vomit. The use of Nutri Compost is to reduce soil compaction and increase root growth, increase beneficial soil microbes, reduce bioavailability of heavy metals etc. Nutri compost possess an array of physical, chemical and biological properties which are difficult to find in any other single product (Lin et al. 2022).

IBA is a synthetic root-promoting hormone that enhance crop production and regulates plant growth along with rapid growth of shoot tissues as well as young leaves with development and elongation (Abdel-Rahman et al. 2020). It has been proven as most reliable in stimulation of root cuttings in large number of plant species also it is non-toxic to plants over its wide concentration range. IBA has vital role in various aspects of root development including regulation of apical roots meristem size also elongation of root hairs with lateral root development and formation of adventitious roots (Sourati et al. 2022).

Composting, a controlled process for stabilization of organic matter, can turn organic waste into a valuable soil amendment. Compost can return nutrients and organic matter to the soil, a proven practice for soil health enhancement. It can improve crop growth and provide environmental benefits by improving soil tilth and the soil's capacity to absorb and hold water and plant nutrients. A properly managed composting process can destroy weed seeds, plant pathogens, and human pathogens. Compost analysis helps assure buyers of bulk compost they are receiving good value for their money. This publication is designed for wholesale buyers of compost for resale, farmers, nursery managers, and public/private landscape managers (Siedt et al. 2021).

To study the effect of various concentrations of IBA on *Ginkgo biloba* cutting for better root development in Nutri Compost. To evaluate different types of cuttings i.e., soft semi & hard wood cutting for propagation of *Ginkgo* on large scale. Conservation of endangered plant and adaptation of Ginkgo biloba to the climatic conditions of Haripur.

MATERIAL AND METHODS

Collection of plant cuttings and climatic

The experimental work was conducted during December, 2017 to June, 2018 in the Qarshi Gardens situated on the main Hattar-Taxila Road in the Haripur District. The cuttings were collected early in the morning from healthy plant and when the plants were turgid. The cuttings were grouped as hardwood (more than a year old) semi hardwood (current season's growth but fairly matured) and softwood (tender growing stems) based on their physiological ages. The cuttings were collected in the month of December from Qarshi owned field. The average length of cuttings was 15 to 20 cm and a diameter of 6.0 to 9.0 mm with 3 to 6 nodes per cutting. The average temperature and relative humidity were recorded by thermometer and hygrometer respectively for the whole period. The minimum and maximum data was recorded in the morning and in the evening time.

Study design

Three types of cuttings were used in the study viz, soft wood, hardwood and semi hard wood. Three different treatments (T1, T2, and T3) of IBA, (300 µM, 600 µM and 900 µM) was applied to each cutting. For each type of cutting one control group was used for comparing the treatment response on root and shooting parameter. The hormone IBA was dissolved in distilled water, and all the cutting were dipped in different concentration of IBA for 5 minutes at room temperature. Control cutting were dipped in distilled water. Each treatment group contains 20 cutting replicated three times as shown in **Table 3.1**. Mean data was recorded for each observation.

Preparation of soil mixture and plantation of cuttings

A soil mixture including herbal compost, clay and sand in 1:1:1 ratio was prepared and moistened with water. Polythene bag (6×3 inch) was filled with the soil and arranged in completely randomized design in different rows. After dipping the cutting for 5 min in IBA was planted in the polythene bags, watered and misted on regular basis. The cuttings were irrigated each after 3 days or according to the need and condition of the environment.

Table: 1 Experimental design of the study, treatment groups and replications

Treatment (*T) & Replications (*R)	**Groups (stem cuttings)**											
	Softwood				**Hardwood**				**Semi hardwood**			
Treatment	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**	**Control**
R1	20	20	20	20	20	20	20	20	20	20	20	20
R2	20	20	20		20	20	20		20	20	20	
R3	20	20	20		20	20	20		20	20	20	

*R=replication (1, 2 & 3), Treatment (*T) T1=300µM IBA, T2=600µM, T3=900µM

Qarshi made Nutri compost

Nutri compost offers a natural source of essential nutrients to promote vigorous plant growth, bountiful yields, and brilliant flowering. best for all-purpose turfs, vegetables, flower gardens, and fruits. It is an organic natural manure obtained by decomposition of herbal raw material waste of natural medicines and Qarshi gardens.

It is 100% natural organic manure with environment friendly, safe and non-irritating organic matter. it improves the structure and texture of the soil, enabling it to better retain nutrients, moisture and air for the betterment of plants. Nutri compost provides many benefits as a soil amendment and a source of organic matter by improving soil's biological, chemical and physical characteristics. The Nutri compost natural compost Qarshi industries (Pvt.) Ltd. Agri and Horti department. The Nutri Compost provide best soil for home gardening is a product of Qarshi industries pvt ltd. the category is tunnel farming and subcategory is garden soil & fertilizers (Figure: 1).

Figure: 1 Nutri Compost made by Qarshi Agri and Horti Department

Data recording and analysis

Data were recorded for the following traits for each cutting and treatment group planted in each polythene bag.

Morphological parameters of shoot

Days to first sprouting were counted from the date of plantation of cuttings. % survival of cuttings was calculated with the help of following formula % Survival= No of sprouted cuttings/ Total cuttings x 100. Shoot length was calculated with the help of scale, taking the average of 10 cuttings. No of branches were calculated with the actual counting of 10 cuttings and taking the average. No of nodes were calculated by counting of 10 cuttings and calculating the average. Leaf area was calculated with the help of this formula Leaf Area = length of leaf x width of leaf. Shoot fresh weight was calculated using electronic weighing balance. Shoot dry weight was calculated using electronic weighing balance (Kovalenko et al. 2020).

Morphological parameters of root

Root length was calculated with the help of scale. No of roots was calculated by taking average of 10 rooted cuttings. No of adventitious roots calculated by taking the average of 10 cuttings. Root girth was calculated with the help of digital vernier caliper. Root fresh weight was calculated by using electronic weighing balance. Root dry weight was calculated by using electronic weighing balance. The data was analyzed using MS excel and SPSS software (Lodhiyal et al. 2023).

RESULT

Climatic condition of Haripur recorded during the study period

The study was conducted in the premises of Qarshi Industries Pvt. Ltd., located in Haripur district in the month of January to June. The agro climatic condition of Haripur region was recorded using thermometer and hygrometer. The table 1 demonstrates the climatic conditions (temperature and % humidity) in Haripur region. The minimum temperature was recorded for the month January 5˚C. The maximum temperature (36˚C) was recorded for the month of June. Similarly, the minimum humidity (33.4 %) was recorded for the month of June whereas, 65.7% humidity was recorded for the month of February, 2018.

Effect of IBA on the sprouting and survival of different types of cuttings

The data in Table 2 demonstrate the effect of different concentrations of IBA on sprouting duration and percent survival of *Ginkgo biloba* cutting. The cuttings were treated with different concentrations of IBA and the duration of sprouting was observed. It was found that, Semi hardwood cutting took less time (17 days) in sprouting at 600 µM concentrations of IBA and 18 days at 900 µM. It was found that all type of cutting treated with IBA at a concentration of 600 µM produce early sprouting as compared to all other group. Similarly, it was observed that the percentage of survival was high for cuttings treated with 600 µM compared to all other groups.

Table: 2 Climatic data recorded for the month of January to June in Qarshi Industries Haripur region

Parameter	Jan		Feb		Mar		April		May		Jun	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temperature(˚C) Thermometer)	5	18	7	19	11	24	15	29	19	34	22	36
Humidity% (Hygrometer)	55.2	61.5	46.1	65.7	40.4	55.3	39.7	54.6	35.1	45.2	33.4	43.5

Table: 3 Effect of different concentrations of IBA on days to sprouting and survival of different types of *Ginkgo* cuttings

Parameters	Days to Sprouting				Percent Survival			
	300 µM	600 µM	900 µM	control	300 µM	600 µM	900 µM	control
Softwood cutting	26	19	22	30	71	75	74	53
Hardwood cutting	23	18	20	28	75	85	80	60
Semi Hard wood cutting	22	17	18	27	76	84	77	64

Morphological parameters of shoot

The effects of IBA on the morphological parameters of shoot of cuttings were evaluated in the month of June, 2018. Different parameters like, shoot length, number of nodes, num of branches, leaf area, shoot fresh and dry weight were observed and recorded.

Effect of IBA on shoot parameters of soft wood cutting

Table 3 and Figure 1, represents the data for various parameters of softwood cuttings treated with 300 µM, 600 µM and 900 µM concentrations of IBA compared to control group. The data shows that 600 µM IBA was best for the performance of morphological parameter of shoot followed by 900 µM concentrations. There was no significant difference in the effect of softwood cuttings treated with 600 & 900 µM concentrations. However, the effect of 300 µM IBA was less.

Table: 4 Effect of different concentrations of IBA on the performance of shoot parameters of softwood cuttings

Parameters	Effect of different IBA levels on soft wood cuttings			
	300 µM	600 µM	900 µM	Control
Shoot length	3.45	4.28	4.04	2.7
Number of branches	3.00	4.00	3.50	2.0
Number of nodes	2.50	3.75	3.50	2.0
Leaf area (cm2)	3.73	3.43	3.42	2.5
Shoot fresh weight (g)	2.65	2.98	2.81	2.45
Shoot dry weight (g)	1.28	1.50	1.39	1.15
LSD Value = 0.05				

Effect of IBA on shoot parameters of hard wood cutting

Different parameters like, shoot length, number of nodes, number of branches, leaf area, shoot fresh and dry weight were also observed and recorded for hardwood cuttings of ginkgo biloba. Table 4 and Figure 2, represents the data for various parameters of softwood cuttings treated with 300 µM, 600 µM and 900 µM concentrations of IBA compared to control group. The data shows that the maximum shoot length (3.77cm) was recorded at 600 µM IBA while the highest no of branches (3.00) was recorded in at 900 µM. Other parameters like no of nodes (3.00), leaf area (3.33cm2), shoot fresh weight (4.12gm), and root dry weight (2.02gm) were also highest in 600 µM. It was observed that no significant results were obtained in shoot parameters by increasing the level of IBA from 600 µM to 900 µM on hardwood cuttings.

Table: 5 Effect of different concentrations of IBA on the performance of shoot parameters of hardwood cuttings

Parameters	Effect of IBA doses on hard wood cuttings of ginkgo			
	300 µM	600 µM	900 µM	Control
Shoot length	3.23	3.77	3.53	2.87
Number of branches	2.75	3.00	3.25	2.0
Number of nodes	2.25	3.00	2.75	1.98
Leaf area (cm2)	3.15	3.33	3.15	2.76
Shoot fresh weight (g)	3.96	4.12	3.55	3.0
Shoot dry weight (g)	2.24	2.02	1.60	1.99
LSD Value = 0.05				

Effect of IBA on shoot parameters of semi hardwood cutting

Similar to softwood and hard wood cuttings we also used semi hardwood cuttings to study the effect of IBA and here we found that semi hardwood cuttings shown best results among all the three types of cuttings i.e., softwood, hard wood and semi hardwood cuttings. As shown in Table 5 and Fig. 3 the maximum shoot length (4.15cm), no of branches (4.25), no of nodes (3.50), leaf area (4.06cm2), root fresh weight (3.19 gm) and root dry weight (1.52gm) were highest with IBA 600 µM compared to all other treatments. It was also noticed no significant gap between 300 µM and 900 µM IBA concentration. It is evident from all the three types of cuttings (softwood, hardwood and semi hardwood) and all the three levels of hormones (300,600,900 µM) the best result was obtained in semi hardwood cuttings treated with 600 µM of IBA. Therefore, the ideal and recommended concentration of IBA for the vegetative propagation of *Ginkgo biloba* is 600µM and the ideal cuttings are semi hardwood cuttings for the better rooting and shooting on commercial scale.

Table 6 Effect of different concentrations of IBA on the performance of shoot parameters of semi hardwood cuttings

Parameters	Effect of IBA on Semi hard wood cuttings of ginkgo			
	300 µM	600 µM	900 µM	Control
Shoot length	3.58	4.15	4.03	3.12
Number of branches	3.50	4.25	4.00	2.6
Number of nodes	3.00	3.50	3.50	1.0
Leaf area (cm2)	3.83	4.06	3.95	2.99
Shoot fresh weight (g)	3.08	3.19	3.03	2.89
Shoot dry weight (g)	1.32	1.52	1.35	1.08
LSD Value = 0.05				

Morphological parameters of roots

The effect of different concentrations of IBA (300, 600 & 900 µM) on root length, root numbers, adventitious roots, root girth, dry and fresh weight. Random sampling was done and the data was recorded in the end of June, 2018. The data was presented in the form of table and graphs.

Effect of IBA on root parameters of soft wood cuttings

Softwood cutting treated with different concentration of IBA exhibited 71-75% sprouting. Based on random observation it was found that 75 % of the cutting sprouted at 600 µM of IBA. Rooting parameters were studied at the 6th month of the treatment. Therefore, it is not clear that how long it takes the root to sprout. Table 6 & Figure 4 demonstrate the effect of different concentration of IBA on softwood cutting of *Ginkgo biloba*. The highest root length (3.9 cm) and maximum number of roots (4.2) was observed at 600 µM IBA. The number of adventitious roots observed was same (3.5)

at both the concentration 600 & 900 µM IBA. Overall, the effect of IBA at 600 µM was good on the root parameters as compared to control group and 300 µM IBA.

Table: 7 Effect of different concentrations of IBA on the performance of root parameters of soft wood cuttings *Ginkgo biloba*

Parameters	**Effect of IBA on rooting of softwood cuttings**			
	300 µM	**600 µM**	**900 µM**	**Control**
Root length (cm)	3.40	3.9	3.63	1.8
Number of roots	3.0	4.2	3.50	2.0
Number of adventitious roots	2.75	3.5	3.50	2.0
Root girth (mm)	1.34	1.6	1.74	1.0
Root fresh weight (g)	2.3	2.4	2.50	1.5
Root dry weight (g)	1.27	1.4	1.30	0.95
LSD Value = 0.05				

Effect of IBA on root parameters of hardwood cuttings

Table 7 demonstrates the effect of IBA on root parameters of hardwood cuttings. It is clear from the table that 600 µM concentrations give good results on the performance of root parameters in the hardwood cuttings. Furthermore, there is no significant increase in the rooting parameter with the increasing concentration of IBA at 900 µM. It was found that there is no significant difference in the performance of rooting parameter at 300 & 900 µM of IBA. The performance of rooting parameter was significantly lowered comparable to 600 µM.

Table: 8 Effect of different concentrations of IBA on the performance of root parameters of hard wood cuttings *Ginkgo biloba*

Parameters	**Effect of IBA on rooting of hardwood cuttings**			
	300 µM	**600 µM**	**900 µM**	**Control**
Root length (cm)	3.8	4.02	3.73	2.1
Number of roots	3.5	3.8	4.0	3.0
Number of adventitious roots	3.25	3.25	2.25	1.0
Root girth (mm)	1.99	1.75	1.78	1.0
Root fresh weight (g)	2.4	2.4	2.50	1.0
Root dry weight (g)	1.53	1.4	1.35	0.56
LSD Value = 0.05				

Effect of IBA on root parameters of semi hard wood cuttings

Effect of IBA with different concentrations were also checked for semi hardwood cuttings of *ginkgo biloba* based by random selection of semi hard wood cuttings to evaluate the effect of hormone on rooting parameters and the results were represented in form of tables and graph. In Table 8 and Graph 6 we came across that maximum Root length (4.9 cm) was observed in 600 µM and minimum root initiated in control 02, while the number of primary and number of adventitious roots, root girth, and root fresh and dry weight in 600 µM were highest among all the other treatments in the experiment. No significant results were observed for the IBA @ 300 and 900 µM which also show that while increasing the concentration of a rooting hormone can significantly cause negative results.

Table: 9 Effect of different concentrations of IBA on the performance of root parameters of semi hardwood cuttings *Ginkgo biloba*

Parameters	**Effect of IBA on rooting of semi hardwood cuttings**			
	300 µM	**600 µM**	**900 µM**	**Control**
Root length (cm)	3.91	4.90	4.31	2.0

Number of roots	3.25	4.50	4.00	2.0
Number of adventitious roots	2.75	3.75	3.25	1.0
Root girth (mm)	1.92	2.60	1.63	1.0
Root fresh weight (g)	2.62	2.68	2.53	1.10
Root dry weight (g)	1.37	1.70	1.08	0.70
LSD Value = 0.05				

Total macronutrient concentrations in Qarshi made Nutri compost

Nutri Compost interpretations provided in Table 5are based on a database of samples from the Qarshi research international lab (QRI). These standard ranges provide useful rules of thumb when considering bulk compost purchase and can be the basis for questions posed to the compost processor. We recommend using a laboratory that participates in the Compost Analysis Proficiency (CAP) in Qarshi research international lab (QRI), the only proficiency testing in the in Qarshi industries international Labatoray that specializes in compost analyses. It enables laboratories and compost users to track the accuracy of test results by submitting the same compost sample to multiple laboratories. Test results are made available so that laboratory managers and their customers can assess the analytical performance of the laboratory. Precision describes the variation in test results for a sample to the same laboratory (intralaboratory precision) or to different laboratories (interlaboratory precision).

Table: 10 Compost nutrient interpretations based on total nutrient analyses.

S. No	Parameter	UoM	Method	Specifications	Results
1	Moisture	g/100g	AOAC-925.10^	NMT 25	52.3
2	pH @ 10%Solution	--	AOAC 981.12	NMT 7.5	7.5
3	Organic Matter	g/100g	Gravimetric	NLT 50	27.78
4	Physical Inspection	-	Physical	Free from Soil, Sand, Seeds, Nematodes, Insects, Pest & Other Harmful Pathogens	Complies
5	Electrical Conductivity (EC)	mm/cm	EC meter	NMT 10	8.1
6	Salt Content	g/100g	Titration	NMT 8	4.3

Table-10 shows data from a set of samples sent to participating laboratories. It does not include variation caused by failure to provide a representative compost sample. Table-10 shows that precision varies with the analytical method. Test results are precise (within 15 percent of the median value) for most routine analyses, such as pH, EC, moisture content, organic matter, physical inspection and salt content. Less precision is observed for salt content and EC tests. Variability depends partly on the magnitude of analysis values. Lower values generally have less precision (more variability). For example, Table-10 shows that variability is higher for moisture than for total organic matter.

In summary, the sample meets the criteria for physical inspection, pH @ 10% Solution, electrical conductivity, and salt content. However, it exceeds the specified limits for moisture content and falls short of the organic matter content requirement. These results are crucial for assessing the quality and suitability of the sample for its intended purpose.

Table: 11 Analytical variability for a compost sample analyzed by Qarshi research international (Pvt.) Ltd.

S. No	Parameter	UoM	Method	Specifications	Results
1	Nitrogen	g/100g	Kjeldahl	Max 1.0	0.93
2	Potassium		AOAC 999.10.11^	Not Available	1.21
3	Magnesium				1.26
4	Calcium				1.24
5	Sodium				0.13
6	Zinc	mg/Kg		Max 350	310
7	Copper			Max 150	70
8	Iron	g/100g		Not Available	0.79
9	Arsenic	mg/Kg		Max 15.0	0.1
10	Cadmium			Max 3.0	0.75
11	Chromium			Max 100	60
12	Lead			Max 120	14.6
13	Nickel			NMT 50	6.0
14	Mercury			NMT 105	ND
15	Selenium			NMT 4	1.2
16	Carbaryl	ug/Kg	AOAC 2007.01	Not Available	22
17	Chlorpyrifos				ND
18	Thiamethoxam				ND
19	Isoprothiolane				ND
20	Acetamiprid				ND

The Table-11 provided appears to contain various parameters and their measurements for a sample, likely related to nutritional content and the presence of certain contaminants or chemicals. the table continues with more parameters, including Cadmium, Chromium, Lead, Nickel, Mercury, Selenium, Carbaryl, Chlorpyrifos, Thiamethoxam, Isoprothiolane, and Acetamiprid, with their respective specifications and results.

Overall, the absence of certain contaminants such as mercury, chlorpyrifos, thiamethoxam, isoprothiolane, and acetamiprid is a positive sign in terms of product safety and quality.

DISCUSSION

Ginkgo biolab is one of the most important plant species that is difficult to propagate from seed easily outside their natural habitat (Bidak et al. 2022). The only way to multiplicate the species in their non-natural habitat is by propagating them from stem cutting. The propagation of *Ginkgo biloba* from semi-hardwood cutting using hormones was first reported by (Morán-López et al. 2020). In the present study we used Auxin (IBA) as rooting hormone for stimulation of roots in semi hard wood, softwood and hardwood cuttings of *Ginkgo biloba*. It has been reported that in natural condition, *Ginkgo biolab* stem cutting take 1-2 years in rooting after plantation. Chauhan et al. (2019) reported rooting in gingko stem cutting treated with IBA inside a poly house in 6 months. Similarly, rooting in three different types of stems cutting of *Ginkgo* treated with IBA in open bed was recorded within the five months period. Our results are more consistent with that of Chauhan et al. (2019) they reported significant root induction (50%) in male cuttings at concentration of 500 µM IBA, however we observed significant number of rooting in all three types of cutting at 600 µM of IBA.

Keeping in mind the immense potential of IBA in root development were used three different concentrations of IBA (300 µM, 600 µM and 900 µM). We observed significant results in root development and morphogenesis of shoot parameter in all type of cuttings. It has been reported that increase in the concentration of auxin increase in plant rooting in stem cutting of Oleander plant, whereas decrease in the concentration the rooting efficiency decrease (Roussos et al. 2022). Similarly,

we observed that increasing the concentration of IBA from 300 µM to 600 µM, the rooting efficiency and subsequent morphological parameters of the shoot significantly increases, however, increasing the concentration further up to 900 µM, we found no significant difference in the efficiency of rooting and morphological parameters of the shoot. Furthermore, we found that IBA at 600 µM is best in rooting efficiency in semi hard wood cuttings as compared to hardwood and softwood cuttings. It has also been reported in the literature that IBA increase the number, number of roots, root length, root fresh and dry weight in cuttings (Gilani et al. 2019). It has been reported that auxin in plant stimulate the rooting and morphogenesis. We also observed that IBA stimulate the induction of roots and morphogenesis in all type of cuttings at all concentrations as compared to untreated control group. However, the best hormonal concentration was 600µM and the best cutting was semi-hardwood cuttings.

CONCLUSION

This study provides preliminary results about cutting propagation of *Ginkgo biloba*. Among all, the best result was obtained in cuttings with 600 µM IBA. The results of this investigation are expected to effective in commercial cutting propagation of *Ginkgo biloba* from semi hard wood cutting.

Secondly, semi hard wood cuttings showed best results among all the three types of cuttings used in the experiment i.e., softwood cuttings and hard wood cuttings so it is recommended that semi hard wood cuttings are best suited for commercial propagation of *Ginkgo biloba*. Moreover, herbal compost may play a significant role in the good aeration and plant microbe interaction in the induction of significant roots in *Ginkgo* cutting. The optimized protocol can be used to develop healthy and profuse root system with shoot bud development and further proliferation. Nutri Compost may synergistically help in the promotion and stimulation of root and shoot morphogenesis in stem cuttings of *Ginkgo biloba*.

Despite of huge medicinal importance and ornamental value, *Ginkgo biloba* has not gained much attention in Pakistan. Therefore, there is an urgent need for the cultivation of this important plant species both for commercial and ornamental purposes.

Collaboration and coordination are necessary between different universities, Research and development institute for the cultivation and propagation of this and many other medicinally and ornamentally important plant species.

Nutri compost may be a good choice to be used as a growth medium along with IBA for propagation purposes.

CONFLICT OF INTREST

No conflict of interest

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