Agricultural Sciences Journal
Available online at http://asj.mnsuam.edu.pk/index.php
ISSN 2707-9716 Print
ISSN 2707-9724 Online
https://doi.org/10.56520/asj.v8i1.584

Research Article

EFFECT OF MORINGA OLEIFERA LEAVES EXTRACT ON THE GROWTH OF VACHELLIA NILOTICA (KIKAR) AT SEEDLING LEVEL

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Abstract

Vachellia nilotica is one of the most valuable timber species in Pakistan. This medium-sized thorny tree is evergreen. A semiarid subtropical environment is ideal for it. Nevertheless, it is able to thrive in driest regions. It has dual medicinal and forage uses. For furniture making, its wood is one of the top tree species in Pakistan. After *Dalbergia sissooo*, furniture of this species is best in terms of quality and durability. It is a slow growing tree. For its faster growth, artificial and organic fertilizers are used at nursery level. In the present study, four treatments were given to the plants excluding the control to evaluate the response of plants. There were eight plants in each treatment and number of replications was three. Thus total number of seedlings in the experiment was 120. A relatively unique method was used in this study for improving its growth rate. *Moringa oleifera* leaf extract (MLE) was applied to the seedlings of *Vachellia nilotica* at concentrations of 0% (control) 2% (T_1), 4% (T_2), 6% (T_3) and 8% (T_4). Data analysis revealed that MLE application significantly enhanced most growth parameters compared to the control. Among the Treatments, 6% MLE (T3) produced the highest shoot and root biomass in *Vachellia nilotica*. The highest leaves fresh weight was observed in T1 (2% MLE) followed by T_0 (Control), T4 (8% MLE) and T3 (6% MLE). Highest root mass allocation was noted in T_2. This study clearly indicates that all concentrations of MLE increased the overall growth of the plants. However, the best performance was recorded under T3 (6% MLE) and T4 (8% MLE). So it is recommended to apply 6% or 8% MLE for best growth of seedlings of *Vachellia nilotica*.

Keywords: *Seedlings, Vachellia nilotica, Moringa leaf extract, Foliar spray, Enhanced growth.*

(Received: 22-Jan-2026 Accepted: 25-April-2026) Cite as: Hammad. M., A. Khayyam., H. Shahid., N. Junaid., Y. Taha., A. H.Masood., H. K. Muhammad., H. Nazer., F. Talha., J. Aiman., A. Muhammad. 2026. Effect of *moringa oleifera* leaves extract on the growth of *vachellia nilotica* (kikar) at seedling level. Agric. Sci. J. 8(1): 12-20.

1. INTRODUCTION

There are more than 120 species of xerophyte plants of the genus *Acacia* (Now *Vachellia*) of the *Fabaceae* family. These trees are cultivated in almost every region of the world under the popular names "*Vachellia*" and "*Senegalia*". *Vachellia nilotica* tree is modest in height, up to 20 meters tall, and evergreen. There have been recorded diameters up to 100 cm. Though it occasionally exhibits conical behavior, the crown is mostly of the spreading type. The tree grows slowly. This tree is indigenous to Pakistan. It can be found in Pakistan's four provinces: Sindh, Punjab, Baluchistan, and KPK. It grows well in areas with limited water supply and is commonly employed as an agroforestry tree in farmlands. *Vachellia nilotica* is adaptable to a wide range of biophysical ranges including temperatures

from 0℃ to 50℃ and rainfall ranging from 250 mm to 1500 mm. It grows at lower elevations than 600 meters. Its pods and bark are used for medicinal purposes (Parveen and Kumar, 2020).

Vachellia nilotica thrives in a variety of natural habitats, including saline marshes, salty deserts, dunes, riverbanks, canals, and coastal beaches. It tends to spread more easily in areas that experience occasional flooding rather than those prone to frequent flooding. Additionally, this species is well-suited to soil with higher salinity levels, allowing it to grow effectively in saline environments. Its wood is utilized as fuelwood and to make Furniture. Leather is tanned using the bark of this plant. It is also used for fencing. It produces an excellent wood for furniture and fuel wood and it also provides tannins, forage, gums and numerous other valuable products. It does well in sandy or hard clay soils and grows well in loamy soil (Panday, 2012). It is an excellent multipurpose tree and the only problem with this tree is that it is slow growing. Organic and artificial fertilizers are applied to *V. nilotica* seedlings for fast growth (Rizvi, 2014).

In the recent years, *Moringa oleifera* has emerged as a natural growth enhancer for fruit plants, agronomic crops, vegetables. Its impact on farm / forest trees has perhaps not been studied in Pakistan particularly in case of *V. nilotica*. Keeping in mind its natural ability to increase the growth rate of many types of plants, this research was conducted to evaluate the impact of *Moringa oleifera* leaf extract on the growth of Kikar (*V. nilotica*) plants at nursery / seedling level. Let's first see some miraculous properties of Moringa plant but we should keep in mind that effect of moringa on tree seedlings perhaps has not been studied. So, available literature shows the effect of moringa on the growth and development of various crops, vegetables and such other type of plants (Abdalla, 2013).

Moringa leaf extract (MLE) is an influential, environment friendly plant growth enhancer. It is rich in Zeatin (a cytokinin) and antioxidants. It fasters plant growth. It enhances the yield of various plants from 20% to 35%. It boosts leaf area, and gives strength to roots. Conclusively, it acts as a natural / organic fertilizer (Barkha Sharma, 2020). A study was carried out to judge the effect of moringa leaf extract on the yield of tomato and spinach. The foliar spray was carried out on both types of plants. The yield of tomato increased by 25%. On the other hand, yield of spinach increased by 20% as compard to control (Mehdawi, 2023). MLE augmented the shoot and root development of maize, lettuce, and beans. Ultimately yield was increased. The improvement in growth rate can be a function of zeatin (cytokinin) which is found in large quantities in Moringa leaves, which enhances cell division (Nihayati and Merynda, 2021).

In a study, MLE was applied to pepper plants as a foliar spray at 4% concentration. The fruit yield including fruit length, diameter and weight was increased significantly as compared to control (Hala *et al.*, 2017). Influence of MLE on beans, ground nut and peas was studied. The plant height and overall biomass production was more in treated plants as compared to non-treated plants (Abu-tahon *et al.*, 2025). A study was carried out to evaluate the impact of MLE on the growth of fig trees and fruit productivity. All the growth parameters including plant height, root length, fresh and dry weight of leaves, shoot and root were improved significantly. Moreover, the fruit yield was also increased significantly as compare to untreated / control trees (Taha, 2024).

The application of MLE significantly / notably improved most of the growth parameters of bitter gourd. No of fruits per plant, no of marketable fruits per plant, fruit

weight and overall yield was increased with the foliar spray of MLE on bitter gourd (Pusta, 2024). A research was carried out to know the impact of MLE on the growth and yield of tomato plants. MLE was applied at the rate of 2%, 4%, 6% and 8% per plant as foliar spray. The MLE in all the concentrations significantly augmented the overall growth and yield of tomato plants. The MLE produced plants with erect stem, regular flowering and branching (Bello, 2024). Keeping in view these miraculous properties of MLE, the present study was carried out to assess the effects of MLE on the growth and development of *V. nilotic* seedlings.

2. MATERIALS AND METHODS

2.1. Site

The study was performed at nursery area of Department of Forestry and Range Management UAF.

2.2. Tree sapling

The saplings of *Vachellia nilotica* were collected from students' experimental area of Department of Forestry and Range Management UAF. The healthy saplings were separated from weaker ones. Only vigorous and healthy saplings were selected for final experiment. All the saplings were homogeneous in healthy and stature. All experiment units were arranged under completely randomized design (CRD). The tree saplings were uniform in age and height.

2.3. Soil media

Silt soil samples were obtained from the Forestry Nursery and Experimental Area Forestry and Range Management UAF. Prior to being placed into pots, the soil was dried and then sieved to ensure uniform particle size.5 kg of prepared soil media in every pots.

2.4. Earthen pots

Soil media was poured into 120 earthen pots. The height and diameter of the vertical column was approximately 18 inches and 12 inches respectively.

2.5. Shifting

One-month old seedling was shifted in the pots from polythene tube.

2.6. Treatment application

The plants were protected and irrigated for 10 days until they adjusted in the new environment. After weeks the Treatment was applied.

2.7. Treatment

5 Treatments were applied with four replications.

T0	(no Treatment)	: control
T1	(foliar spray)	: 2 grams
T2	(foliar spray)	: 4grams
T3	(foliar spray)	: 6 grams
T4	(foliar spray)	: 8 grams

2.8. Weighing balance

A weighing balance was used to determine the weight or mass of plant samples. It was available in research lab.

2.9. Oven

A sample drying oven (DHG-9202 Electro thermal Thermostatic Drying Oven) was used to dry samples Leaves, Stem and Roots. The box body, both internal and external, is constructed using high-quality steel sheets that are welded together. The surface undergoes electrostatic spraying Treatment. The internal workroom either finished stainless steel or coated with high temperature resistant silver paint. The door is equipped with observation window or double-door structure. Its appearance stylish modern, while offering energy-saving benefits. The temperature control system is based on a microcomputer and features an intelligent digital display. It ensures accurate and reliable temperature control, displaying both the preset temperature and actual temperature inside the box simultaneously. Additionally, it includes alarm functions for over-temperature, heat, electronic leakage, and sensor failure, as well as a timing function. An intelligent LCD temperature controller is also available as an optional feature.

2.10. Growth parameters

The recorded data includes the following parameters.

1. Plant height (cm)
2. Root length (cm)
3. Stem diameter (mm)
4. Number of leaves
5. Leaves fresh weight (g)
6. Leaves dry weight (g)
7. Shoot fresh weight (g)
8. Shoot dry weight (g)
9. Root fresh weight (g)
10. Root dry weight (g)
11. Root shoot ratio (%)

2.11. Statistical Analysis

The obtained data were subjected to two-way analysis of variance (ANOVA) to evaluate the effects of species and Treatment. Differences between group means were assessed using Tukey's Honest Significant Difference (HSD) test. All results are expressed as means ± standard error (SE), and statistical significance was determined at the $P<0.05$ level, following the method described by Sokra, 2025.

3. RESULTS

3.2. Plant height:

The maximum plant height (45.75 cm) was obtained under T_4 followed by T_2 (43.83 cm) and T_0 (41.58 cm) (Table. 1). There was no continuous pattern of increase in plant height under various treatments. The data clearly indicates that T_4 is the best treatment for increase in plant height of *V. nilotica* (kikar).

Treatment	Plant height (cm)
T_0 : (Control)	41.58 bc
T_1 : (2% MLE)	38.41 bc
T_2 : (4% MLE)	43.83 ab
T_3 : (6% MLE)	35.66 c
T_4 : (8% MLE)	45.75 a

Table: 1: Effect of various concentrations of *Moring oleifera* leaf extract on the plant height of *Vachellia nilotica*

3.2. Shoot length:

The maximum shoot length (table-2) was obtained under T_1 (31.11 cm) followed by T_4 (30.52 cm) and T_2. (29.45 cm) (Table. 2). Again, the best results were achieved under T_4. It means that *Moringa* leaf extract @ 8% is most beneficial in obtaining the highest shoot length.

Treatment	Shoot length(cm)
T_0 : (Control)	27.91a
T_1 : (2% MLE)	31.11a
T_2 : (4% MLE)	29.45a
T_3 : (6% MLE)	23.25b
T_4 : (8% MLE)	30.52a

Table: 2: Effect of various concentrations of *Moring oleifera* leaf extract on the shoot length of *Vachellia nilotica*

3.3. Root length:

The maximum root length (15.22 cm) was obtained under T_4 followed by T_2 (14.63 cm) and T_0 (13.83 cm) as shown in table -3. It is obvious that result of T4 is best of all (Table. 3).

Treatment	Root length(cm)
T_0 : (Control)	13.83ab
T_1 : (2% MLE)	13.21ab
T_2 : (4% MLE)	14.63a
T_3 : (6% MLE)	12.01b
T_4 : (8% MLE)	15.22a

Table: 3: Effect of various concentrations of *Moring oleifera* leaf extract on the root length of *Vachellia nilotica*

3.4. Stem diameter:

Maximum stem diameter (2.63 mm) was obtained under T_0 followed by T_1 (2.54 mm) and T_4 (2.47) as shown in table-4. It is obvious that best results in terms of stem diameter were shown by control. But the difference in results under the three treatments mentioned earlier was not statistically different from one another (Table. 4).

Treatment	Stem diameter (mm)
T_0 : (Control)	2.63a
T_1 : (2% MLE)	2.54a
T_2 : (4% MLE)	2.18b
T_3 : (6% MLE)	2.19b
T_4 : (8% MLE)	2.47ab

Table: 4: Effect of various concentrations of *Moring oleifera* leaf extract on the stem diameter of *Vachellia nilotica*

3.5. Number of leaves:

The maximum number of leaves (273.33) was obtained under T_0 followed by T_1 (263.33) as shown in table-5. On the other hand, minimum number of leaves (226.66) was obtained under T_4 (Table. 5).

Treatment	Number of leaves
T_0 : (Control)	273.33a
T_1 : (2% MLE)	263.33a
T_2 : (4% MLE)	251.66a
T_3 : (6% MLE)	251.66a
T_4 : (8% MLE)	226.66b

Table: 5: Effect of various concentrations of *Moring oleifera* leaf extract on the Number of leaves of *Vachellia nilotica*

3.6. Leaves fresh weight.

The maximum fresh weight of leaves (3.15 g) was obtained under T_1 followed by T_4 (3.14 g) and T_2 (3.13 g) as indicated in table-6. Again, there is no continuous pattern of increase or decrease in leaves fresh weight under various treatments (Table. 6).

Treatment	Leaves fresh weight (g)
T_0 : (Control)	3.08b
T_1 : (2% MLE)	3.15a
T_2 : (4% MLE)	3.13a
T_3 : (6% MLE)	3.09b
T_4 : (8% MLE)	3.14a

Table: 6: Effect of various concentrations of *Moring oleifera* leaf extract on the leaves fresh weight of *Vachellia nilotica*

3.7. Leaves dry weight:

The maximum leaves dry weight (1.61g) was obtained under the treatment T_2, followed by T_4 (1.60 g) and T_1 (1.41g). But the results under these three treatments are statistically non-significant (Table. 7).

Treatment	Leaves dry weight (g)
T_0 : (Control)	1.26
T_1 : (2% MLE)	1.41
T_2 : (4% MLE)	1.61
T_3 : (6% MLE)	1.12
T_4 : (8% MLE)	1.60

Table: 7: Effect of various concentrations of *Moring oleifera* leaf extract on the leaves dry weight of *Vachellia nilotica*

3.8. Shoot fresh weight:

The maximum shoot fresh weight (0.55 g) was obtained under T_0 followed by T_2 (0.43 g) and T_4 (0.42 g) as shown in table-8. The result under T_0 was found to be statistically different from T_2 and T_4 (Table. 8).

Treatment	Shoot fresh weight (g)
T_0 : (Control)	0.55a
T_1 : (2% MLE)	0.35b
T_2 : (4% MLE)	0.43ab
T_3 : (6% MLE)	0.35b
T_4 : (8% MLE)	0.42ab

Table: 8: Effect of various concentrations of *Moring oleifera* leaf extract on the shoot fresh weight of *Vachellia nilotica*

3.9. Shoot dry weight:

The maximum shoot dry weight (0.15) was obtained under the treatment T_0, followed by T_4 (0.11) and T_3 (0.06) as shown in table-9. The results among the three treatments mentioned earlier were found to be statistically different from one another (Table. 9).

3.10. Root fresh weight:

The maximum fresh weight (0.21g) of plants was obtained underT_4, T_3 (0.17 g) and T_1 (0.16 g) as shown in table-10. The results

under T_4 were found to be statistically different from T_3 and T_1 (Table. 10).

Treatment	Shoot dry weight (g)
T_0 : (Control)	0.15a
T_1 : (2% MLE)	0.05cd
T_2 : (4% MLE)	0.03d
T_3 : (6% MLE)	0.06c
T_4 : (8% MLE)	0.11b

Table: 9: Effect of various concentrations of *Moring oleifera* leaf extract on the shoot dry weight of *Vachellia nilotica*

Treatment	Root fresh weight (g)
T_0 : (Control)	0.14b
T_1 : (2% MLE)	0.16b
T_2 : (4% MLE)	0.15b
T_3 : (6% MLE)	0.17b
T_4 : (8% MLE)	0.21a

Table: 10: Effect of various concentrations of *Moring oleifera* leaf extract on the root fresh weight of *Vachellia nilotica*

3.11. Root dry weigh:

The maximum dry weight of plants (0.06 g) was obtained under T_0 followed by all other treatments equally (0.05 g) as shown in table-11. The results under T_0 were statistically different from all other treatments (Table. 11).

Treatment	Root dry weight (g)
T_0 : (Control)	0.06a
T_1 : (2% MLE)	0.05b
T_2 : (4% MLE)	0.05ab
T_3 : (6% MLE)	0.04b
T_4 : (8% MLE)	0.05b

Table: 11: Effect of various concentrations of *Moring oleifera* leaf extract on the root dry weight of *Vachellia nilotica*

3.12. Root / shoot ratio:

The maximum root / shoot ratio (68.16) was obtained by the plants under the treatment T_3, followed by T_1 (61.63) and T_2 (47.79). Statistically, the results among T3 and T2 were found to be significantly different from one another (Table. 12).

Treatment	Root / shoot ratio
T_0 : (Control)	45.78b
T_1 : (2% MLE)	61.63ab
T_2 : (4% MLE)	47.79b
T_3 : (6% MLE)	68.16a
T_4 : (8% MLE)	46.33b

Table: 12: Effect of various concentrations of *Moring oleifera* leaf extract on the root / shoot ratio of *Vachellia nilotica*

4. DISCUSSION

The current study was designed to evaluate the potential of *Moringa oleifera* leaf extract (MLE) as a natural biostimulant for enhancing the growth and biomass of an important xerophytic tree species i.e. *Vachellia nilotica* under nursery conditions. The rationale behind this study stems from the increasing global interest in sustainable and eco-friendly practices in afforestation, especially in arid and semi-arid regions where water and soil fertility constraints limit conventional growth.

MLE is known to contain a rich composition of bioactive compounds including vitamins (A, C, E), minerals (Ca, K, Mg, Fe), amino acids, phenolics, flavonoids, and plant hormones such as cytokinins (particularly zeatin), auxins, and gibberellins. These compounds are widely documented to influence plant metabolic pathways, enhance photosynthetic efficiency, improve nutrient uptake, and increase stress tolerance (Zulfiqar *et al.*, 2020).

4.1. Impact on Xerophytic Tree Growth

The application of MLE significantly improved growth parameters such as plant height, stem diameter, number of leaves, and both fresh and dry biomass of V. nilotica and T. aphylla. These results are consistent with previous findings where MLE increased the shoot and root biomass of crops like maize, tomato, lettuce, and beans. The enhancement in growth can be largely attributed to zeatin,

a cytokinin abundantly found in Moringa leaves, which stimulates cell division and delays senescence (Bashir *et al.*, 2014).

4.2. Physiological and Biochemical Influence

MLE's role in improving the physiological functioning of treated plants was evident from the increased biomass allocation and root-shoot ratios. According to, *Moringa's* antioxidant compounds protect the photosynthetic machinery from oxidative damage, thereby sustaining higher chlorophyll content and photosynthetic activity. This protection allows for greater carbohydrate synthesis, which in turn promotes biomass accumulation (Elzaawely *et al.*, 2016).

MLE-treated plants also exhibited enhanced root mass and allocation, which may be attributed to the presence of auxins in the extract. Auxins are well known to stimulate root initiation and elongation, facilitating improved water and nutrient absorption. The increase in below-ground biomass further supports previous findings where MLE application improved root morphology and nutrient uptake efficiency in maize and spinach (Islam *et al*., 2021).

4.3. MLE as an Organic Biostimulant

MLE's efficacy as a foliar spray has been extensively demonstrated across a variety of crops and environmental settings. Research shows that the foliar application route allows rapid uptake and immediate utilization of the phytohormones and nutrients present in the extract (Shahzad *et al*., 2014). In this study, foliar spraying of MLE at concentrations of 2%, 4%, 6%, and 8% showed a dose-dependent positive impact, with 6% and 8% concentrations yielding the most promising results.

Moreover, the antioxidant components in MLE, including phenolic acids and flavonoids, contribute to reducing oxidative stress in plants, which is particularly beneficial in xerophytic species subjected to abiotic stress. These properties also play a pivotal role in maintaining membrane stability, delaying senescence, and prolonging leaf area duration, all contributing to enhanced plant productivity (Peñalver *et al*., 2022).

4.4. Ecological and Practical Implications

The use of MLE as a biostimulant offers a sustainable and low-cost alternative to synthetic agrochemicals, aligning with ecological restoration goals in arid zones. The significant increase in biomass and growth of *V. nilotica* suggests that MLE could be integrated into afforestation programs to improve seedling survival and establishment in degraded lands. Its role in improving early-stage plant vigor is particularly critical in ensuring the success of plantation projects in harsh environments (Yasmeen *et al.*, 2012).

Given the growing challenges of climate change, soil salinity and desertification, especially in regions like Pakistan, the findings of this study advocate for the incorporation of MLE-based Treatments in nursery practices. This aligns with previous studies advocating for the use of organic bio stimulants to replace or reduce the reliance on chemical fertilizers (Taha *et al*., 2015).

5. CONCLUSION

The results of current research work indicate clearly that Moringa leaf extract is an effective bio-stimulant for accelerating the growth of *Vachellia nilotica* at nursery level. So, it is recommended that the nursery growers should apply Moring leaf extract on *V. nilotica* seedlings as a foliar spray at 2 to 8% concentration for producing healthy plants for transplanting in the field.

6. CONFLICT OF INTEREST

There is no conflict of interest among the authors.

7. ACKNOWLEDGMENTS

The authors are grateful to their colleagues especially the forest nursery staff who

encouraged them to carry out this research work.

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