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RESEARCH ARTICLE

FOLIAR APPLICATION OF SYNTHETIC AND A POTENTIAL ORGANIC SOURCE GROWTH HORMONES ON COCOA SEEDLING DEVELOPMENT

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ABSTRACT

The study examines how the morphological development and survival of cocoa (*Theobroma cacao L.*) seedlings in a nursery establishment are affected by the foliar application of synthetic and organic growth hormones. The experiment was conducted in one of the screen houses of the Cocoa Research Institute of Nigeria, using a Completely Randomized Design with four treatments: Auxin at 100 mg/L (AUX), Indole-3-Acetic Acid at 100 mg/L (IAA), Moringa Leaf Extract at 100 g/L (MOR), and a control (CN). Nursery polythene bags (12.5 cm by 25 cm) filled with 2 mm sieved topsoil were used. The F3-Amazon cocoa variety was used in this experiment with one cocoa bean seed sown per polythene. 10 polythene stands were used per treatment, 40 per replication and 120 stands for the 3 replications. Data on morphological parameters, survival count, and root characteristics were assessed. Data obtained were analyzed using descriptive analysis and ANOVA while treatment means were separated using the Least Significant Difference at 0.05% probability. Results showed that Auxin treatment significantly reduced seedling survival, with complete mortality at 12 WAS, while others maintained 100% survival. The moringa treatment (MOR) had the tallest seedlings height (25.60 cm) and thicker stem diameters (6.85 mm) at 12 WAS while IAA had the highest leaf count (12.75), dry root weight (0.96 g) and root score (2.67). Moringa leaf extract can be used as a cheap, organic and alternative source for growth enhancement of cocoa seedlings as it either performs better or the same as the other synthetic hormones.

KEYWORDS

Cocoa seedlings; Foliar application; Growth hormones, Moringa leaf extract; Nursery

1. INTRODUCTION

Cocoa (*Theobroma cacao* L.) is an essential economic crop in tropical regions, particularly in West Africa, where countries like Nigeria, Ghana, and Côte d'Ivoire dominate global production (Kongor et al., 2024). The early stages of cocoa seedling growth are critical for successful field establishment, overall productivity, and the long-term sustainability of cocoa plantations. One key factor influencing seedling development is the availability of plant growth regulators (PGRs), which play a vital role in physiological processes such as cell elongation, root formation, and nutrient absorption (Farman et al., 2019).

Synthetic growth hormones, particularly Auxins and Indole-3-Acetic Acid (IAA), have been extensively studied for their ability to promote root and shoot growth in various crops (Naveed et al., 2015; Keswani et al., 2020). However, growing concerns over the environmental impact and high costs associated with synthetic hormones have sparked interest in organic alternatives, such as plant-based bio-stimulants.

Moringa (*Moringa oleifera*) has gained attention as a potential natural source of plant growth hormones due to its rich content of phytohormones, antioxidants, and essential nutrients (Yasmeen, 2011; Sadak et al., 2024). Research indicates that moringa leaf extracts contain significant amounts of auxins, cytokinins, and gibberellins, which can enhance plant growth and improve stress tolerance (Basra and Lovatt, 2016; Elzaawely et al., 2017). Due to its positive effect on the growth of other crops, there is a need to study its effect on the growth and development of cocoa seedlings in the nursery. It could however also be a cheaper organic alternative as against the use of conventional synthetic hormones. Therefore, the aim of this study is to observe the effect of the synthetic hormone and a potential organic source hormone on the growth and development of cocoa seedlings in the nursery. Furthermore, this study will also look into the performance of the moringa leaf extract as against its synthetic counterparts.

2. MATERIALS AND METHODS

2.1 Study Location

This experiment was established at the Soil and Plant Nutrition Department screen house of the Cocoa Research Institute of Nigeria in Oyo State, Southwestern Nigeria.

2.2 Experimental Design and Treatments

The experimental design of this study was a Complete Randomized Design (CRD). The synthetic growth hormones used are Auxin and Indole-3-acetic acid which were applied at the same rate of 100 mg/L while the potential organic source growth hormone used was Dry Moringa Leaf extract (Moringa Tea Powder) applied at the rate of 100 g/L. A control treatment with no hormone application was also set making a total number of 4 treatments which are Auxin @ 100 mg/L (AUX), Indole-3-acetic acid @ 100 mg/L, Dry Moringa Leaf Extract @ 100 g/L (MOR) and the control (CN). The treatments were replicated 3 times in this study.

2.3 Soil Preparation and Sowing

Topsoil used was, air-dried, and sieved through a 2 mm mesh. Each nursery polythene bag of 12.5 cm by 25 cm was filled with 800 grams of

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topsoil. Samples of the topsoil were taken to the lab for routine analysis. The F3-Amazon cocoa variety pods sourced within the institute were used as each polythene bag was sown at the rate of one cocoa bean per polyethylene bag. A total of 120 stands of the nursery polythene bags were sown as 40 stands were used per replication and 10 stands per treatment in each replication. The polythene bags were placed on a raised platform in the screen house.

2.4 Treatment preparation and Imposition

100 mg of both synthetic hormones (Auxin and Indole-3-acetic acid) were separately dissolved in a bowl with 1 liter of water each before transferring the solutions into separate 1-liter spaying bottles. 100 g of Moringa Tea Powder was also thoroughly mixed with 1 liter of water and then sieved before transferring into a 1-liter spaying bottle. The hormones were sprayed on the cocoa seedlings at 4, 5 and 6 weeks after sowing.

2.5 Data Collection

Data on growth parameters such as plant height (cm), number of leaves, stem diameter (mm), and leaf area (cm^2), were measured every two weeks from one month after sowing (MAS) until three months after sowing. Data on survival count was recorded at 3 MAS. At the end of the experiment (3 MAS), seedlings were carefully uprooted, and roots were washed and separated from the shoots to obtain data on tap root length and dry root weight after drying the samples to a constant weight at 70°C. Seedling root scoring was also done using a scale of 1 to 3 where 1 represents "poor", 2 represents "fair" and 3 represents "good" as used by researcher (Kerner et al., 2009).

2.6 Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using Minitab Statistical Software (version 17). Treatment means were separated using Fisher's Standardized Range Test at a 0.05 significance level.

3. Result and Discussions

The result from Table 1 shows that the soil is generally suitable for raising cocoa seedlings due to its high Organic Carbon content (20.9 g/kg), neutral pH (7.13), adequate nitrogen (1.63 g/kg), sufficient phosphorus (19.3 mg/kg) and moderate potassium (0.47 cmol/kg) according to the soil nutrient fertility rating of a researcher (Chude et al., 2012). The textural class of the soil belongs to the sandy clay loam classification.

Table 1: Chemical and physical properties of the topsoil

Soil Parameters	Value
pH	7.13
Organic Carbon (g/kg)	20.9
Nitrogen (g/kg)	1.63
Phosphorous (mg/kg)	1.93
Potassium (cmol/kg)	0.47
Calcium (cmol/kg)	4.65
Magnessium (mg/kg)	1.32
Particle Size	
Sand (g/kg)	608
Silt (g/kg)	120
Clay (g/kg)	272
Textural Class	Sandy Clay Loam

All treatments maintained a 100% seedling survival rate at 4 and 6 WAS indicating that no mortality was observed before the application of the hormones at 4 WAS and at two weeks after the application of the hormones (Table 2). However, at 8 WAS, a 50% decline in survival was observed in Treatment AUX which implies that the hormone negatively affected seedling growth as other treatments (CN, IAA and MOR) still maintained a 100% survival rate. At 10 WAS, treatment AUX had a complete mortality rate (0%) which indicates that all cocoa seedlings subjected to Auxin treatment didn't survive beyond 10 weeks while other treatments maintained 100 % survival till 12 WAS. From this result (Table 2), it could be said that Auxin at the rate applied had an adverse effect on cocoa seedlings as a growth hormone despite its positive effect on the growth and development of some other crop plants as reported by researchers (Çakmakçı et al., 2020; Jiang et al., 2025). Though Auxin is essential for plant growth, a higher concentration can result in oxidative stress usually leading to cell death (Farman et al., 2019). In addition, when its concentration is high, it can act as a growth inhibitor (Farman et al., 2019).

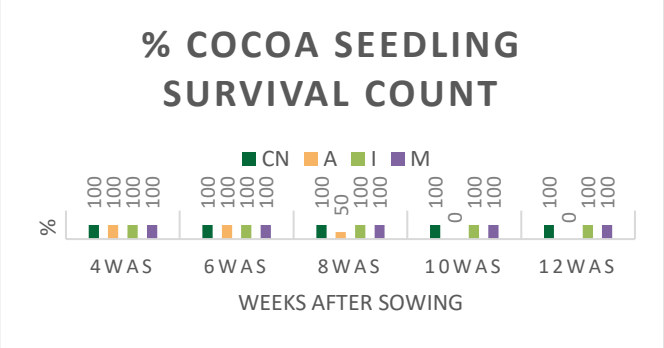

Figure 1: Cocoa seedling survival count from 4 to 12 weeks after sowing

For seedling height, at 4 and 8 WAS, there were no significant differences among treatments (CN, AUX, IAA, and MOR), as all recorded statistically similar heights (Table 2). However, at 12 WAS, MOR had the tallest seedling height (25.60 cm) which is statistically similar to the control treatment (25.13 cm). IAA (21.20 cm) had a noticeably shorter seedling height when compared with MOR and CN. This implies that the organic material outperformed both synthetic hormones in terms of seedling height and also had a relatively higher seedling height than the control treatment. A similar trend was also observed for the number of leaves as there were no significant differences among treatments at 4 and 8 WAS (Table 2). At 12 WAS, CN, IAA, and MOR supported continuous leaf development, with IAA showing the highest leaf count (12.8 leaves). Seedlings subjected to treatment AUX didn't make it to 12 WAS as explained in Figure 1, the reason for the zero being recorded for both the seedling height and numbers of leaves in Table 2 and in summary, IAA producing the highest number of leaves, while MOR recorded the tallest seedlings.

Table 2: Cocoa seedling height and No. of leaves as influenced by growth hormones

TREAT	Seedling Height (cm)			Seedling No. of Leaves		
	4MAS	8MAS	12MAS	4MAS	8MAS	12MAS
CN	18.25^{a}	21.20^{a}	25.13^{a}	4.5^{a}	7.3^{a}	10.3^{a}
AUX	19.40^{a}	20.10^{a}	0.00^{c}	4.5^{a}	2.0^{a}	0.0^{b}
IAA	16.33^{a}	19.50^{a}	21.20^{b}	6.5^{a}	8.3^{a}	12.8^{a}
MOR	18.00^{a}	20.95^{a}	25.60^{a}	4.3^{a}	6.3^{a}	9.0^{a}

Treatments with the same letter(s) are not significantly different

At 4 and 8 WAS, there were no significant differences among treatments (CN, AUX, IAA, and MOR), as all recorded relatively similar values of stem diameter as shown in Table 3. MOR produced the thickest stem (6.85 mm) followed by IAA (6.60 mm) and CN (6.33 mm) respectively at 12 WAS. However, they are all statistically the same. For leaf area, all treatments had statistically the same leaf area at 4 WAS (Table 3). By 8 WAS, treatments CN (43.44 cm^2) and MOR (44.79 cm^2) recorded significantly larger leaf areas than both AUX (24.59 cm^2) and IAA (24.95 cm^2). At 12 WAS, the control treatment CN (51.68) recorded the largest leaf area of all the treatments followed by MOR (44.37 cm^2) with a statistically similar value. Overall, MOR produced the thickest stems while CN recorded the largest leaf area.

Table 3: Cocoa seedling stem diameter and leaf area as influenced by growth hormones

TREAT	Seedling Stem Diameter (mm)			Seedling Leaf Area (cm^2)		
	4MAS	8MAS	12MAS	4MAS	8MAS	12MAS
CN	3.88^{a}	4.90^{a}	6.33^{a}	28.10^{a}	43.44^{a}	51.68^{a}
AUX	3.70^{a}	4.65^{a}	0.00^{b}	31.02^{a}	24.59^{b}	0.00^{c}
IAA	4.05^{a}	5.03^{a}	6.60^{a}	20.26^{a}	24.95^{b}	30.45b^{c}
MOR	4.50^{a}	5.43^{a}	6.85^{a}	30.90^{a}	44.79^{a}	44.37^{ab}

Treatments with the same letter(s) are not significantly different

For root length as shown in Table 4, there were no significant differences among treatments. CN (15.0 cm) and IAA (14.8 cm) recorded the longest roots respectively, while MOR (13.5 cm) had the shortest, though the

differences were not statistically significant. This suggests that all three hormone treatments did not influence the root elongation of cocoa seedlings.

A similar trend was also observed for the dry root length as no significant differences were observed among the treatments. However, IAA (0.96 g) recorded the highest dry root weight, followed closely by CN (0.90 g) and MOR (0.87 g). For dry root weight, all treatments also showed similar values, with IAA (0.96 g) recording the highest dry root weight, followed closely by CN (0.90 g) and MOR (0.87 g). For the root score which showed how dense or fibrous the roots are, Table 4 reveals that IAA (2.67) had the best and a relatively good root system and significantly better than CN (1.33) with a relatively poor root system. However, MOR (2.00) with a fair root system was not significantly different from IAA (2.67). This suggests that treatment IAA promoted better root system development in terms of structure and robustness while MOR also showed a positive potential to do the same.

Generally, the study reported that an increase in the rate of moringa leaf extract brought about an increase in all growth parameters of maize which implies that a higher rate than the one used in this study can probably or totally out performed IAA as an externally applied organic hormone (Biswas et al., 2016).

Table 4: Cocoa seedlings' destructive sample parameters as influenced by growth hormones

TREAT	Root Length (cm)	Dry Root Weight (g)	Root Score
CN	15.0[a]	0.90[a]	1.33[b]
IAA	14.8[a]	0.96[a]	2.67[a]
MOR	13.5[a]	0.87[a]	2.00[ab]

Treatments with the same letter(s) are not significantly different

4. Conclusion

This study underscores the importance of selecting appropriate foliar-applied growth hormones for improved growth and development of cocoa seedlings. Foliar application of Auxin at 100 mg/L negatively impacted cocoa seedling growth, leading to complete mortality within 4 weeks after application while seedlings sprayed with Indole-acetic acid (IAA) and the moringa leaf extract all maintained 100% survival.

Looking at the growth parameters, moringa leaf extract distinctly showed the potential to improve cocoa seedling height and stem diameter while IAA also distinctly showed the potential to improve cocoa seedling's leaf production, dry root weight and good root development. However, the moringa leaf extract can be used as a cheap, organic and alternative source for growth enhancement of cocoa seedlings as it either performed better or the same as the other synthetic hormones.

A repeat of this study is recommended to further validate the observations from this study while further study should also explore the biochemical mechanisms underlying the adverse effects of Auxin spray on cocoa seedling.

References

Basra, S. M., and Lovatt, C. J., 2016. Exogenous applications of moringa leaf extract and cytokinins improve plant growth, yield, and fruit quality of cherry tomato. HortTechnology, 26(3), Pp. 327-337.

Biswas, A. K., Hoque, T. S., and Abedin, M. A., 2016. Effects of moringa leaf extract on growth and yield of maize. Progressive Agriculture, 27(2), Pp. 136-143.

Çakmakçı, R., Mosber, G., Milton, A. H., Alatürk, F., and Ali, B., 2020. The effect of auxin and auxin-producing bacteria on the growth, essential oil yield, and composition in medicinal and aromatic plants. Current Microbiology, 77, Pp. 564-577.

Chude, V. O., Daudu, C., Olayiwola, S. O., and Ekeoma, A. (Eds.)., 2012. Fertilizer use and management practices for crops in Nigeria (4th ed.). Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development.

Elzaawely, A. A., Ahmed, M. E., Maswada, H. F., and Xuan, T. D., 2017. Enhancing growth, yield, biochemical, and hormonal contents of snap bean (Phaseolus vulgaris L.) sprayed with moringa leaf extract. Archives of Agronomy and Soil Science, 63(5), Pp. 687-699.

Farman, S., Mushtaq, A., and Azeem, M. W. (2019). Plant growth regulators (PGRs) and their applications: A review. Int. J. Chem. Biochem. Sci, 15, Pp. 94-103.

Farman, S., Mushtaq, A., and Azeem, M. W., 2019. Plant growth regulators (PGRs) and their applications: A review. Int. J. Chem. Biochem. Sci, 15, Pp. 94-103.

Jiang, N., Zou, T., Huang, H., Li, C., Xia, Y., and Yang, L. (2024). Auxin synthesis promotes N metabolism and optimizes root structure enhancing N acquirement in maize (Zea mays L.). Planta, 259(2), Pp. 46.

Kerner, S., Katsahian, S., Sarfati, A., Korngold, S., Jakmakjian, S., Tavernier, B., and Bouchard, P., 2009. A comparison of methods of aesthetic assessment in root coverage procedures. Journal of clinical periodontology, 36(1), Pp. 80-87.

Keswani, C., Singh, S. P., Cueto, L., García-Estrada, C., Mezaache-Aichour, S., Glare, T. R., and Sansinenea, E., 2020. Auxins of microbial origin and their use in agriculture. Applied Microbiology and Biotechnology, 104, Pp. 8549-8565.

Kongor, J. E., Owusu, M., and Oduro-Yeboah, C., 2024. Cocoa production in the 2020s: Challenges and solutions. CABI Agriculture and Bioscience, 5(1), Pp. 102.

Naveed, M., Qureshi, M. A., Zahir, Z. A., Hussain, M. B., Sessitsch, A., and Mitter, B., 2015. L-Tryptophan-dependent biosynthesis of indole-3-acetic acid (IAA) improves plant growth and colonization of maize by Burkholderia phytofirmans PsJN. Annals of microbiology, 65, Pp. 1381-1389.

Sadak, M., El-lethy, S., and Hanafy Amin, R. S., 2024. Assessing the usefulness of Moringa oleifera leaf extract and zeatin as a biostimulant in enhancing growth, phytohormones, antioxidant enzymes and osmoprotectants of wheat plant under salinity stress. Egyptian Journal of Botany, 64(3), Pp. 183-196.

Yasmeen, A., 2011. Exploring the potential of moringa (Moringa oleifera) leaf extract as natural plant growth enhancer. Doctor of Philosphy in Agronomy, Department of Agronomy Faculty of Agriculture, University Of Agriculture, Faisalabad, Pakistan.