Current Investigations in Agriculture and Current Research
DOI: 10.32474/CIACR.2023.10.000347
ISSN: 2637-4676
Research Article

Tolerance of Moringa Oleifera L, Jatropha Curcas L, and Albizia Lebbeck L Seeds Germination to Greenhouse Gases Pollution

Odeyemi Muritala[1], Babatunde Taofik Ademola[1]*, Kalimullah Sagir[1] and Abdulshaheed Nuruddeen Lawal[2]

[1]*Department of Biology, Faculty of Science, Umaru Musa Yara'adua University, Nigeria.*

[2]*Teachers Registration Council of Nigeria*

***Corresponding author:** Babatunde Taofik Ademola, Department of Biology, Faculty of Science, Umaru Musa Yara'adua University, PMB 2218, Katsina, Nigeria

Received: May 01, 2023 **Published:** May 24, 2023

Abstract

The use of forest reserves as a carbon sink triggered afforestation programs as urban settlements around the world were characterized by poor air quality, especially greenhouse gas pollution. In this research, the tolerance of germination of Moringa oleifera, Jatropha curcas, and Albizia lebbeck to atmospheric greenhouse gas was evaluated. Ten seeds each of the three species were planted in ceramic pots (35% porosity) filled with mixtures of soil and manure in an equal ratio. A steel frame as support for a transparent polythene sheet was used to cover the plants, and the control experiment was maintained in a similar environment. Smoke was supplied to each treatment for one minute daily for 15 days using a petro-powered motorcycle, Jincheng JC110-19V, with a 4-stroke engine. At the end the experiment, the germination of Moringa oleifera seeds was not significantly different ($p > 0.05$) between the treatment and control, while Jatropha curcas and Albizia lebbeck (26% and 32%, respectively) in the control were significantly higher ($p < 0.05$) compared to the exposed seed, with 18% and 14% germination, respectively. A similar trend was observed in the chlorophyll contents of the leaves 15 Days After Sowing (DAS) and biomass yield 20 DAS. The results of this work showed that all three species tolerated elevated environmental greenhouse pollutant concentrations for germination, while Moringa had a higher tolerance.

Keywords: Tolerance; germination; Moringa oleifera; Jatropha curcas; Albizia lebbeck; Greenhouse gases

Introduction

Air pollution is an important issue due to fast industrial development as it results in human health problems such as ophthalmic, respiratory, and cardiovascular diseases [1-4]. Health complications, notably chronic obstructive pulmonary diseases, acute respiratory infections, lung cancer, and heightened mortality, have also been reported due to air pollution [5,6]. The World Health Organization (WHO) confirms that 92% of the world's population lives in areas with poor air quality that frequently exceed the WHO limit [7]. The current air pollution emission control technologies to remove emissions of air pollutant like greenhouse gases from the environment or convert it into less toxic forms are not sufficient to meet the environmental challenges [8]. Greenhouse gas is any gas that has the property of absorbing and emitting radiant energy within the thermal infrared range [9]. These gases include carbon dioxide (CO_2), organic chemicals called chlorofluorocarbons (CFCs), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and water vapour (H_2O). Carbon dioxide is the important gases because of the huge volumes emitted into the air by combustion of fossil fuels (e.g., gasoline, oil, coal) [10]. It can also be obtained as a by-product of breathing and fermentation. The greenhouse gases from human activities are the most significant drivers of observed climate change [9]. As human activities increase, greenhouse gas emissions build up in the atmosphere and warm the climate, leading to many other changes in the world. If this phenomenon persists over a long period of time, it can lead to major problems for present and future generations.

[11]. assert that many of the counteractive solutions in place for greenhouse gas emissions are focused on mitigation ways to slash emissions as quickly as possible, such as by adopting renewable energy, promoting energy efficiency, and stopping deforestation. Forests are not only vital for human life by providing a diverse range of resources; they also serve as carbon sinks and produce oxygen that is vital for the existence of life on the earth, so they are regarded as the earth's lungs. It reduces global warming and absorbs toxic gases and pollution. But now-a-days, forest cover is depleting rapidly due to many reasons, such as an expansion of agriculture, timber plantations, other land uses like pulp and paper plantations, urbanization, the construction of roads, and industries, which constitute the biggest and most severe threat to the forest, causing serious environmental damage [12]. hence the need for afforestation. In northern Nigeria, afforestation programs by the government, intergovernmental organizations, and private agencies are on the rise. The choice of trees for the afforestation program in the area is basically based on drought tolerance. In this research, the tolerance of three of the species, namely Moringa oleifera, Jatropha curcas, and Albizia lebbeck, which are popularly used for afforestation in the area, was evaluated with an emphasis on greenhouse gases.

Materials and Method

Study Location

This study was carried out in the biological garden of Umaru Musa Yar`adua University, Katsina State between June, and September 2022. The area lies between longitude of 12.8858°N and longitude of 7.5735°E. The area is characterized by a distinct wet season (May to October) and dry season (November to April).

Collection and Preparation of Planting Materials

Seeds of Moringa oleifera, Jatropha curcas, and Albizia lebbeck, as well as soil and manure, were obtained from the Umaru Musa Yaradua University botanical garden. The ceramic pots were filled with soil and manure mixed in an equal ratio. The pots were watered and allowed to drain for 24 hours through the holes. Planting was carried out by sowing 10 seeds each of Moringa oleifera, Jatropha curcas, and Albizia lebbeck in each pot. Seeds of Jatropha curcas were pretreated by soaking in water for 48 hours [13]. The pot porosity was about 35%. The experiment was maintained outdoors in their native environments at 30-32°C and 12 hours of photoperiod.

Pollution Exposure

A petro-powered motorcycle, Jincheng motorcycle, with model number of JC110-19V, 4-stroke engine type with a gas/diesel certification was used to supply smoke to the treatments. Plants were exposed to one minute of smoke daily from sowing until 15 days, when no more germination was observed. A frame made from steel and a transparent nylon was used to cover the plants. Control was planted in open air.

Measurement of Seed Germination

Germinated seeds were counted daily according to the Association of Official Seed Analysts [14]. The seeds were considered as germinated when the radical size was 2 mm. Seed germination was monitored daily for treatment and control. The number of seeds germinated was recorded, and the percentage of seed germination and significant differences were determined with T-test analysis.

Chlorophyll Estimation

After germination (20 days), one gram of leaf sample was finely cut and gently mixed with a clean pestle and mortar. To this homogenized leaf material, 20 mL of 80% acetone and 0.5 g of $MgCO3$ powder were added. The leaf was further grinded gently. The sample was then put into a refrigerator at 40 °C for 4 hours. Thereafter, the sample was centrifuged at 500 rpm for 5 minutes. The supernatant was transferred to a 100-liter volumetric flask. The final volume was made up to 100 mL with the addition of 80% acetone. The color absorbance of the solution was estimated by a spectrophotometer using 645 and 663 nm wavelengths against the solvent. Acetone (80%) was used as a blank [15].

Seedling Biomass Determination

Above ground parts were harvested and weighed immediately, and the fresh shoot biomass was obtained. Samples were then dried in an oven for 3 hours at 105 °C and weighed for moisture content estimation [16]. Weighing was frequent and recorded until constant weights were achieved. Results were recorded, and significant differences were determined with T-test analysis.

Results

Seed Germination

Moringa oleifera, seed germination was not significantly different ($p>0.05$) between the treatment (40%) and control (42%). In Jatropha curcas, a significantly higher germination percentage ($p<0.05$) was recorded in the control (26%), while the exposed seed had 18% germination. A similar trend was observed in Albizia lebbeck, with germination of 14% in the treatment and 32% in the control.

Chlorophyll Contents

The chlorophyll contents of Moringa leaves were 28.0 mg/m3 and 27.5 mg/m3 for the treatment and control, respectively. Jatropha curcas showed a significant difference ($p<0.05$) in the leaf chlorophyll content between the treatments (2.78 mg/m3) and the control (4.76 mg/m^3). A similar trend was observed in Albizia seedling leaves.

Citation: Odeyemi Muritala, Babatunde Taofik Ademola*, Kalimullah Sagir and Abdulshaheed Nuruddeen Lawal. Tolerance of Moringa Oleifera L, Jatropha Curcas L, and Albizia Lebbeck L Seeds Germination to Greenhouse Gases Pollution. Curr Inves Agri Curr Res 10(5)-2023. CIACR.MS.ID.000347. DOI: 10.32474/CIACR.2023.10.000347

Biomass Yield

The effect of smoke on fresh and dry weights of Moringa oleifera, Jatropha curcas, and Albizia lebbeck is shown in Table 1. The mean fresh weights of Moringa seedlings 20 days after sowing were 19.70 g in the treatment and 23.39 g in the control, and this was significantly different (p<0.05). A similar, significant higher wet weight of Albizia was observed in the control (p<0.05). Whereas Jatropha wet weight was significantly higher in the treatment (p<0.05).

Table 1: Biomass (mean± SD) of Moringa oleifera, Jatropha curcas and Albizia lebbeck seedlings.

Plants	Fresh Shoot Weight (G)		Dry Shoot Weight (G)	
	Treatment	Control	Treatment	Control
Moringa oleifera	19.70±1.34[a]	23.39±2.71[a]	6.08±1.22[a]	7.95±1.26[b]
Jatropha curcas	316.32±47.36[a]	233.32±56.36[b]	86.18±14.39[a]	59.40±17.60[b]
Albizia lebbeck	66.60±7.98[a]	78.20±19.29[b]	4.06±0.21[a]	5.36±1.98[b]

Discussion

The results demonstrated that different plant species respond in different ways to smoke pollution, and this may be attributed to species' pollution tolerance capabilities. The seed germination study revealed that air pollution (smoke) did not affect the seed germination of Moringa oleifera significantly, while Jatropha curcas and A. lebbeck germination were affected by pollution stress due to the addition of smoke derived from the automobile. The presence of air pollutants in the immediate environment can directly affect the plant's ability to germinate effectively. The germination and growth of plants under stress and in a polluted environment have been studied [17-20]. Our current finding also supported this. Chlorophyll is the index of productivity in plants [21]. Chlorophyll content of plants varies from species to species, age of leaf and with the pollution level as well as with other biotic and abiotic condition. Thus, plants with high chlorophyll content show tolerance to air pollution. The chlorophyll content of Moringa oleifera, Jatropha curcas, and Albizia lebbeck leaves were significantly affected by the smoke pollution. This result agrees with those obtained by [21]. who reported that air pollution significantly lowered the Chlorophyll content of Azadirachta indica, Mangifera indica, Nerium oleander, and Dalbergia sissoo leaves. The variation in chlorophyll content could be due to smoke accumulation on leaf surfaces. Photosynthesis is highly sensitive to air pollution; therefore, measurement of chlorophll in leaves is conceptually regarded as a useful diagnosis to determine the subtle pollutant effects. Chlorophyll is an index of productivity of plant [22]. as well as development of biomass, is the principal photoreceptor in photosynthesis. Degradation of photosynthetic pigment has been widely used as an indication of air pollution [23]. The higher the levels of pollutants, the lower the lower the chlorophyll content [21,24]. suggested that the pollutant gases such as SO_2, NO_2, and O_3 produce oxyradicals in reaction with the pollutants, which cause damage to the membrane and associated molecules, including chlorophyll pigment. The smoke emission from the auto exhaust has greatly influenced the seedlings' dry biomass capability. These results show that biomass production of plants was more sensitive to air pollutant as reported by [20,25,26]. Similarly, there was also a significant (p <0.05) increase in the dry biomass of Jatropha compared to the plants in the control. For high biomass production, these stand as key means of determining carbon sequestration potential, photosynthesis, and maximum crop growth and yield.

Conclusion

The germination of Moringa oleifera seeds in this work was significantly affected by smoke, while Jatropha curcas and Albizia lubbeck were also significantly affected. Therefore, different species of plants respond differently to environmental changes. Conversely, the wet biomass yield (20 DAS) was higher for Jatropha. This implies that a plant species may respond to air pollution differently during its life cycle. The results of this work showed that all three species tolerated elevated environmental carbon dioxide concentrations for germination, while Moringa had a higher tolerance.

References

1. Brunekreef B, Holgate ST (2002) Air Pollution and Health. Lancet 360(9341): 1233-1342.
2. Nandasena YLS, Wickremasinghe AR, Sathiakumar N (2010) Aira rPollution and Health in Sri Lanka: a Review of Epidemiologic Studies. BMC Public Health 10(100).
3. Giles LV, Barn PKN, Romieu I, Mittleman MA, Eeden S, et al. (2011) From good intentions to proven interventions: effectiveness of actions to reduce the health impacts of air pollution. Environ Health Perspect 119(1): 29-36.
4. Gudmundsson G (2011) Respiratory Health Effects of Volcanic Ash with Special Reference to Iceland. A review. The Clinical Respiratory Journal 5(1): 2-9.
5. Kumar M, Singh RS, Banerjee T (2015) Associating airborne particulates and human health: exploring possibilities. Environ Int 84: 201-202.
6. Banerjee T, Kumar M, Mall RK, Singh RS (2017) Airing "clean air" in clean India mission. Environ Sci Pollut Res 24(7): 6399-6413.
7. WHO (2016) Ambient air pollution: a global assessment of exposure and burden of diseases.
8. Amann M, Bertok I, Borken Kleefeld J, Cofala J and Heyes C, et al. (2011) Cost-effective control of air quality and greenhouse gases in Europe: Modeling and policy applications. Environmental Modelling and Software 26(12): 1489-1501.
9. IPCC (2013) The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change 1535.

10. Kweku DW, Bismark O, Maxwell A, Desmond KA, Danso KB, et al. (2018) Greenhouse effect: greenhouse gases and their impact on global warming. Journal of Scientific research and reports 17(6): 1-9.

11. Levin I, Hamme S, Eichelmann E, Vogel FR (2011) Verification of greenhouse gas emission reductions: the prospect of atmospheric monitoring in polluted areas. Philosophical Transactions of the Royal Society A: Mathematical Physical and Engineering Sciences 369(1943): 1906-1924.

12. Hughes AC (2017) Mapping priorities for conservation in Southeast Asia. Biological Conservation 209: 395-405.

13. Leishangthem CL, Rana A (2017) Seed size and pre sowing treatment effect on germination of some tropical and subtropical trees-a review. International Journal of Current Microbiology and Applied Sciences 6(7): 2637-2645.

14. (1990) Association of Official Seed Analysis (AOSA) Rules for testing seeds. J Seed Technol 12: 1-112

15. (1989) American Public Health Association. Standard methods for the examination of water and wastewater 17th ed. Washington D C American Public Health Association.

16. Cordeiro DS, Raghavan GSV, Oliveira WP (2006) Equilibrium moisture content models for Maytenus ilicifolia leaves. Biosystems Engineering 94(2): 221-228.

17. Gilbertson P, Bradshaw AD (1985) Tree survival in cities; the extent and nature of the problem. Arboricultural Journal 9(2): 131- 142.

18. Jehan S, Iqbal MZ (1992) Morphological and anatomical studies of leaves of different plants affected by motor vehicular exhaust. Journal of Islamic Academy of Science 5(1): 21-23.

19. Sawidis T, Marnasidis A, Zachariadis GA, Stratis JA (1995) A study of air pollution with heavy metals in Thessaloniki city (Greece) using trees as biological indicators. Archives of Environmental Contamination and Toxicology 28: 118-124.

20. Shafiq M, Iqbal MZ (2012) Effect of autoexhaust emission on germination and seedling growth of an important arid tree Cassia siamea Lamk. Emirates Journal of Food and Agriculture 24(3): 234-242.

21. Giri C, Pengra B, Long J, Loveland TR (2013) Next generation of global land cover characterization, mapping, and monitoring. International Journal of Applied Earth Observation and Geoinformation 25(1): 30-37.

22. Bell JNB, Mudd CH (1976) Sulphur dioxide resistance in plants: a case study of a Loliun perenne. Mansfield TA (Ed) Effects of Air Pollutants on Plants.

23. Ninave SY, Chaudhri PR, Gajghate DG, Tarar JL (2001) Foliar biochemical features of plants as indicators of air pollution. Bull Environ Contam Toxicol 67(1): 133-140.

24. Allen LH, Boote KL, Jones JW, Jones PH, Valle RR, et al. (1987) Response of vegetation to rising carbon dioxide photosynthesis, biomass and seed yield of soybeans. Global Biogeochemical Cycle 1(1): 1-14.

25. Nwadinigwe AO (2014) Air pollution tolerance indices of some plants around Ama industrial complex in Enugu State, Nigeria. African Journal of Biotechnology 13(11): 1231-1236.

26. Singh SN, Verma A (2007) Phytoremediation of Air Pollutants: A Review. Environmental Bioremediation Technology pp. 293-314.

DOI: 10.32474/CIACR.2023.10.000347