World Journal of Agricultural Research, 2023, Vol. 11, No. 1, 16-21
Available online at http://pubs.sciepub.com/wjar/11/1/3
Published by Science and Education Publishing
DOI:10.12691/wjar-11-1-3

Effect of Different Watering Regimes on Morphological Parameters of Cashew Grafted Genotypes

Bi Zan Alexis DOBO[1], KOUAKOU Charles Konan[2,*], Kouame Kevin Koffi[1]

[1]Breeding and Crop Husbandry Unit, Faculty of Natural Sciences, 02 PO Box 801, Abidjan 02, Nangui Abrogoua University, Abidjan, Ivory Coast
[2]National Center of Agronomic Research, Kilometer 17, Dabou Road 01 PO Box 1740 Abidjan, Ivory Coast
*Corresponding author: charles_kokou@yahoo.fr

Received February 02, 2023; Revised March 05, 2023; Accepted March 15, 2023

Abstract Water stress has a strong influence on the physiological functions of tree crops which adversely affects the growth and yield of tree plants. Drought and soil fertility are the major factors that influence seedling survival and growth in arid areas, thus it is of paramount importance to establish optimum water requirements for tree seedlings in order to promote growth. In line with this, an investigation was carried out to assess early growth behaviours of *Anacardium occidentale* when exposed to varied watering intervals in the greenhouse. Two month old grafted seedlings were used for the study in 1.08 liter plastic pots containing 2 kg of potting soil. Seedlings were exposed to five different watering intervals (every two days, every four days, every six days, every eight days and ten days) and 80 mL of water was administered per each seedling based on the watering frequency for two months. Six seedlings were allocated per watering frequency and replicated 4 times in a Split-plot design. The result revealed a significant effect of irrigation frequency on seedlings growth of *Anacardium occidentale* where seedlings that received water every two days and every four days produced highest growth in the variables measured. Administering 80 mL of water per seedling every two days and every four days improved growth of A. *occidentale* in the nursery.

Keywords: *Anacardium occidentale, seedling, watering frequency, grafted genotypes, water*

Cite This Article: Bi Zan Alexis DOBO, KOUAKOU Charles Konan, and Kouame Kevin Koffi, "Effect of Different Watering Regimes on Morphological Parameters of Cashew Grafted Genotypes." *World Journal of Agricultural Research*, vol. 11, no. 1 (2023): 16-21. doi: 10.12691/wjar-11-1-3.

1. Introduction

Cashew (*Anacardium occidentale* L.) is a perennial tree crop and a member of the family Anacardiaceae. The center of origin is north-eastern Brazil but was introduced to West Africa by the early Portuguese settlers in the 16th century [1]. Introduced in Ivory Coast in 1951, it was only from 1959-1960 that cashew plantation programmes were carried out and extended to the entire ecologically favourable zone, particularly the Sudano-Guinean savannahs [2]. Since 1970, the cashew tree has become a cash crop in Ivory Coast, whose production has increased, due to the increase in world nut prices [3]. The cashew tree is considered a resistant, drought-adapted plant, which explains why there is a lack of interest in investigating its response to irrigation [4]. Water is an important component of plants. Adequate amount of water is critical to successful tree nursery operation among resource-constrained smallholder farmers in Africa [5]. Water requirement of any tree depends on the botanical characteristics of the plant, its stage of growth and weather conditions [6]. Plant water status strongly influences plant growth and biomass production particularly through its effects on leaf and root expansion. This implies that growth and biomass production is directly proportional to the supply and use of water [6]. The growth, development, and reproduction of plants require sufficient water [7]. The reduction of the water availability in the soil may cause a loss of cell turgor which in turn reduces gas exchange and leaf elongation since both are turgor-dependent processes [8]. Yet water is becoming scarcer globally and every indication is that it will become even more so in the future [9]. Decreasing availability, declining quality, and growing demand for water are creating significant challenges to businesses and investors who have traditionally taken clean, reliable and inexpensive water for granted [9]. Availability of permanent water supply has been one of the major challenges in tree nursery establishment and management, especially in the drier regions of the tropics and sub-tropics. Initial growth of seedlings largely depends on stored food reserves contained in the cotyledons and also availability of soil moisture [10]. For the establishment of cashew tree nurseries, it is important to consider the

reduction in the availability of water in the world. However, no information on watering frequencies of young cashew seedlings was not yet available.

The objective of this study was to determine the effect of different watering regimes on selected cashew grafted genotypes.

2. Materials and Methods

2.1. Plant Materiel

The plant material used in this research is two month old grafted cashew seedlings namely A1 karakoro, POK25, KK38 and W9, grown in pots with a capacity of 1.08 litres, water, and well-sieved potting soil. The instrument used in this study are: agricultural equipment, an electronic weighing scale, calipers, and a greenhouse for water control.

2.2. Description of the Study Site

This study was conducted in a greenhouse at National Agricultural Research Center in Lataha (Korhogo), Ivory Coast. Lataha (altitude: 350 m above sea level, latitude: 9°34' N, longitude: 5°34' O) is situated at about 22 km from Korhogo in the north part of Ivory Coast. The natural vegetation consists of wooded savannah. The soils are ferralitic, moderately to highly desaturate. The climate, of Sudanese type, is characterised by two seasons: a dry season, from November to April and a rainy season, from May to October. The average annual rainfall is 1400 mm in wet years and 1000 mm in dry years [11].

2.3. Experimental Layout and Design

The experiment was laid out in a greenhouse at Cashew Research Station in Lataha, Ivory Coast from August 2021 to March 2022. The layout was a two factorial experiment (genotypes and watering regimes) in a Split-Plot with 4 replications. The nuts of the different genotypes were sown in pots with a capacity of 1.08 litres. When the seedlings reached the age of 3 months, grafting was carried out with the scions taken from the mother trees of the same genotypes. The seedlings were watered with 80 milliliters of water per pot at five watering regimes applied as follows:

1. Watering regime1 (W_1): watering after every 2 days
2. Watering regime 2 (W_2): watering after every 4 days
3. Watering regime 3 (W_3): watering after every 6 days
4. Watering regime 4 (W_4): watering after every 8 days
5. Watering regime 5 (W_5): watering after every 10 days

Other abiotic factors (temperature, light, relative humidity and the potting media) were uniformed.

2.4. Data Recording

Data on temperature and relative humidity (RH) were done using a Tynitag which recorded maximum and minimum temperatures and RH. The specifications of the Tynitag used were as follows: Temperature/Relative Humidity (-25 to +85°C/0 to 100% RH).

The experiment duration is 8 weeks after that destructive measure was done on roots biomass. The data on morphological parameters were recorded as follows:

Leaf number per seedling

The number of fully unfolded leaves per plant was obtained by visual counting at the end of the experiment.

The length of the leaves

The length of the leaf was measured using a meter rule from the petiole to the tip.

Plant height

The plant height (cm) was measured vertically using a meter rule from the base to the tip of the seedling at the end of the experiment.

Collar diameter

The collar diameter (mm) was obtained by measuring the diameter at the collar point with the use of a Vernier calliper.

Stem and root dry weight

At the end of the experiment, the seedlings were destructively sampled for determination of stem and root dry weight. This was achieved by dissecting the pot using a sharp knife and carefully separating the seedlings from the soils with all the roots intact. Any soil attached on the roots was shaken off. Each seedling was then separated into stem and root, oven dried at 70°C for 48 hours and weighed using a sensitive balance.

Seedling survival

At the end of the experience, seedling survival was determined by visual counting.

2.5. Data Analysis

The data was subjected to analysis of variance (ANOVA) using STATISTCA version 7.1 and effects declared significant at 5% level. Least Significance Difference (LSD5 %) was used to separate the means.

3. Results

3.1. Effect of Watering Regimes on Seedling Survival

A survival rate of 100% was observed in seedlings watered every two days and every four days in A1 Karakoro and W9 genotypes. In both genotypes, the application of 80 mL of water every six days resulted in 20 and 25% survival rates in A1 Karakoro and W9 respectively. The application of 80 mL of water every eight days resulted in a 0% survival rate in the A1 Karakoro, while in the W9 it was 5% treatments. Watering with 80 mL of water every ten days resulted in a 0% survival rate in both genotypes. The survival rate of both genotypes was resumed by Figure 1 and Figure 2.

A survival rate of 100% was observed in seedlings watered every two days in POK25 and KK38 genotypes. In both genotypes, the application of 80 mL of water every four days resulted in 100 and 95% survival rates in POK25 and KK38 respectively. The application of 80 mL of water every six days resulted in a 10 % survival rate in the POK25, while in the KK38 it was 8 %. Watering with 80 mL of water every ten days resulted in a 0% survival

rate in both genotypes. The survival rate of both genotypes was resumed by Figure 3 and Figure 4.

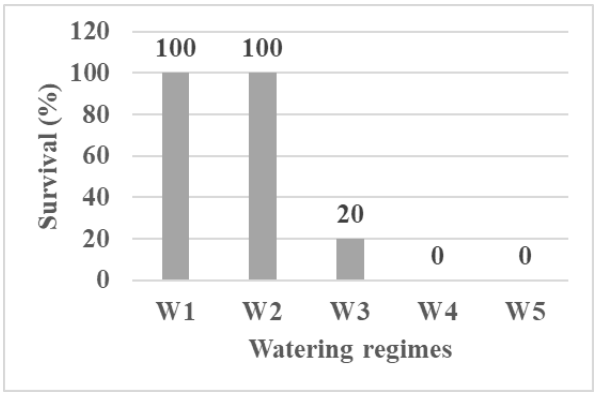

Figure 1. Effect of watering regimes on A1 karakoro seedlings survival rate

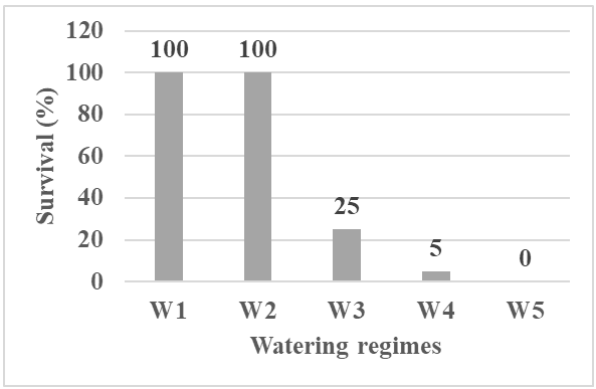

Figure 2. Effect of watering regimes on W9 seedlings survival rate

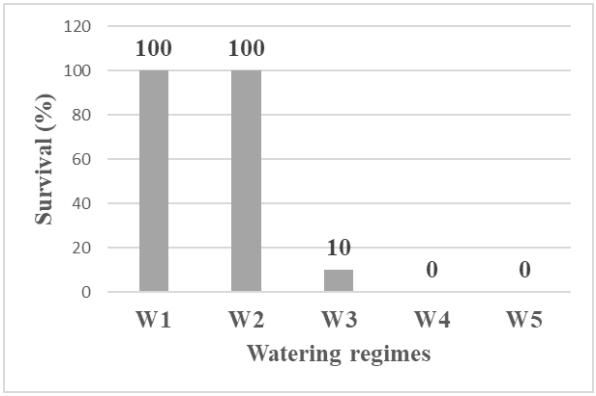

Figure 3. Effect of watering regimes on POK25 seedlings survival rate

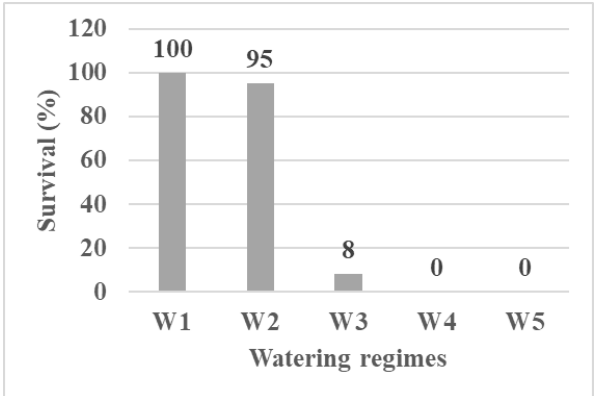

Figure 4. Effect of watering regimes on KK38 seedlings survival rate

3.2. Effect of Watering Regimes on Number of Leaves

A significant effect ($p < 0.05$) was observed in watering frequencies on number of leaves of seedlings, two months after the application of the different treatments (Figure 5). Watering every two days and watering every four days had higher number of leaves. It was respectively (10.57 leaves) and (7.66 leaves). With the watering every six days, the number of leaves was (5.25 leaves). The least number of leaves was recorded from seedlings that received water every eight days and every ten days. It respectively 3.07 and 1.48 leaves.

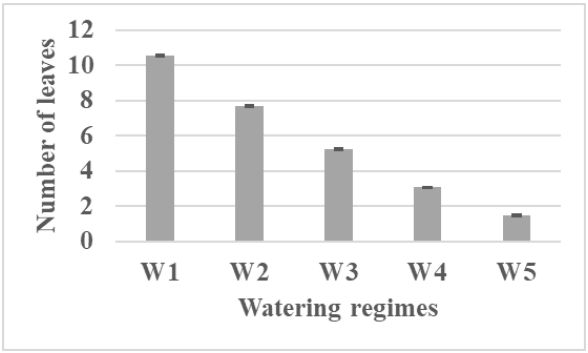

Figure 5. Effect of watering regimes on number of leaves

3.3. Effect of Watering Regimes on the Length of the Leaves

A significant effect ($p < 0.05$) was found in seedlings leaves length exposed to different watering frequencies. The seedlings that received water every two days and every four days had significantly higher length of the leaves. It was respectively (11.60 cm) and (11.10 cm) compared to seedlings that were exposed to watering once every six days (10.63 cm), every eight days (8.48) and every ten days (6.18 cm) (Figure 6).

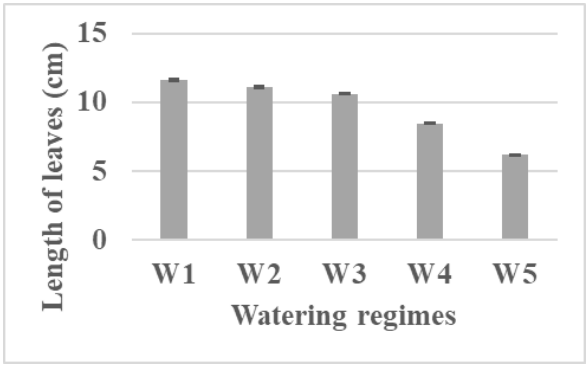

Figure 6. Effect of watering regimes the length of the leaves

3.4. Effect of Watering Regimes on of the Plant Height

Watering frequency was found to have a significant ($p < 0.05$) effect on seedlings height and 25.35 cm was the highest height recorded in seedlings watered every two days. The least height of seedlings (20.87 cm) was recorded from seedlings that received water every ten days. The height was (24.21 cm) in seedlings watered every four

days, 23.45 cm in seedlings watered once every six days. In seedlings watered every eight days, the height was 22.92 cm (Figure 7).

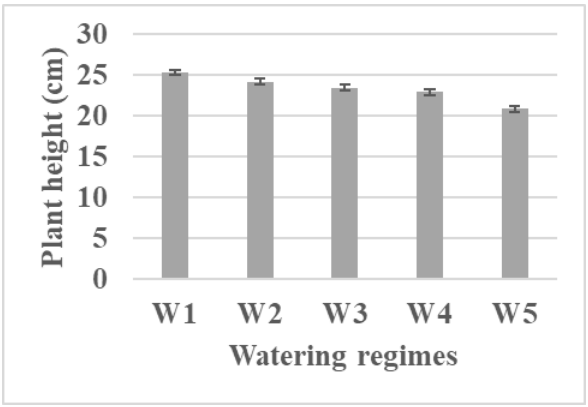

Figure 7. Effect of watering regimes on plant height of cashew genotypes

3.5. Effect of Watering Regimes on Collar Diameter

There was a significant ($p < 0.05$) effect on seedlings collar diameter exposed to various watering frequencies. Figure 8 shows the mean seedlings collar diameter, where watering every two days recorded the highest collar diameter (5.72 mm). It was followed by seedlings that received water every four days (5.30 mm) and every six days (5.09 mm). The least collar diameter of seedlings (4.50 mm) was recorded from seedlings that received water every ten days.

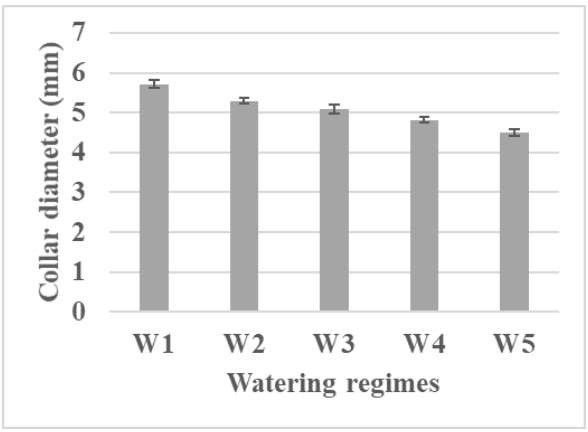

Figure 8. Effect of watering regimes on plant collar diameter of cashew genotypes

3.6. Effect of Watering Regimes on Stem Dry Weight

Stem dry weight was significantly ($p < 0.05$) influenced by watering frequency (Figure 9). Seedlings that received watering every two days produced significantly higher stem dry weight (2.84 g). There was followed by seedlings that received water every four days (2.48 g). The seedlings that received water every six days and every eight days had dry stem weights of 2.36 g and 1.88 g. Those that received water every ten days had the least stem dry weight (1.75 g).

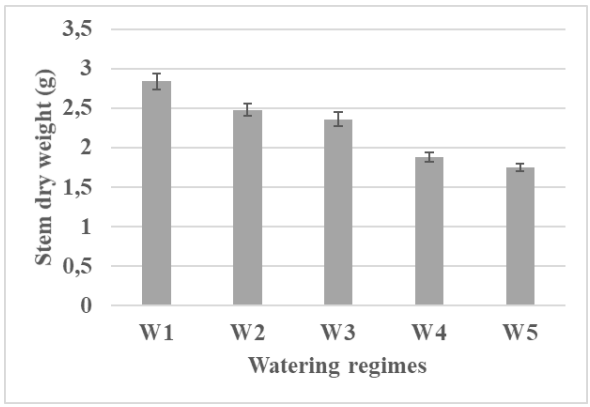

Figure 9. Effect of watering regimes on stem dry weight of cashew genotypes

3.7. Effect of Watering Regimes on Root Dry Weight

Root dry weight was significantly ($p < 0.05$) influenced by watering frequency (Figure 10). Seedlings that received watering every two days yielded significantly higher root dry weight (1.81 g). There was followed by seedlings that received water every four days (1.53 g). The seedlings that received water every six days and every eight days had dry root weights of 1.33 g and 1.23 g. Those that received water every ten days had the least root dry weight (0.99 g).

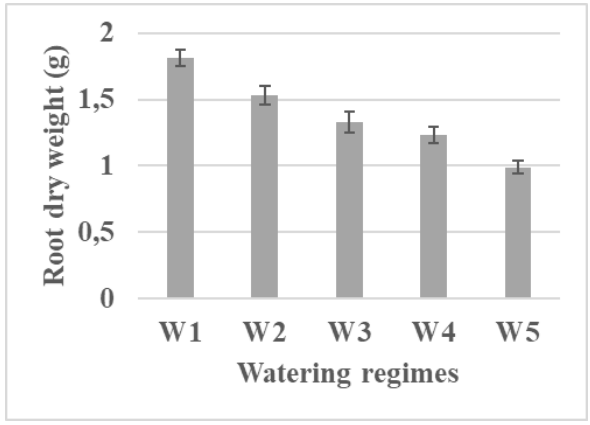

Figure 10. Effect of watering regimes on root dry weight of cashew genotypes

4. Discussion

Plant roots require proper soil environmental conditions for good growth. These conditions include the appropriate amounts of water, air and minerals, the proper pH and temperature, these requirements are related to the physiology of the plant [10]. A high percentage of survival for A1 Karakoro, POK25, KK38 and Waraniéné 9 seedling was obtained from water application every two days and every four days. The seedlings percentage survival with these frequencies was 100 %. 80 ml of water applied to both species every six days, every height days and every ten days greatly reduced seedling survival. The low survival rate observed in seedlings watered every eight and every ten days may be due to a lack of water

given the time gap between watering. Water is a major component of all living organisms and is involved in important biochemical processes, including photosynthesis. Its availability in adequate quantity and at a biologically tolerable interval can affect the behaviour of a plant species. In addition, the current findings may indicate that genotypes are sensitive to watering frequency. Either two or four day interval of water application increased the number of leaves when compared with the rest. The results, support the work of [12] where higher number of leaves was obtained from seedlings of coffee that were watered every two and four days. The results suggest that 80 ml of water applied at two and four days intervals improved photosynthetic and transpiration area due to increase of number of leaves, increased seedling height, survival. In contrast, 80 ml of water applied at eight and ten days intervals had a negative effect on seedling number of leaves and the length of leaves. The reduction in leaf number and possibly area under limited water quantity due to the interval of watering could be a mechanism to reduce transpiration so as to avoid wilting of seedlings. Considering labour costs involved and based on the present results, it would be advisable for nursery operators to irrigate cashew seedlings every two or four days under the prevailing conditions.

Seedlings Growth in height was significantly improved by watering frequency where watering every two and four days yielded higher growth in height than watering every six, eight and ten days. This may be due to high photosynthesis rate and root moisture absorption rates [13]. These findings partly disagreed with the result of [14] who recorded highest growth of *Parkia biglobosa* seedlings that were watered once in five days over seedlings watered once daily and once in three days. The species characteristics could be responsible for this variation.

Also, these observations are contrary to those of [15] who reported high growth of seedlings of *Acacia senegal* that were watered once after fourteen days over the same seedlings watered once daily and weekly. This could be due to the species water requirement, environment, season of growth and state of the seedlings.

Stem dry weight was significantly influenced by watering frequency. Seedlings that received watering every two and four days produced higher stem dry weight. These observations are in a agreement to those of [16] who reported high stem dry weight of seedlings of coffee (*Coffea canephora* P. var Robusta) that were watered once after two and four days.

5. Conclusion

Estimation of tree seedlings water requirement and frequency of watering is essential in irrigation scheduling and water resource management. A consistent and adequate source of water supply is essential for all tree seedling nurseries. Variation was found between both tree seedling genotypes with respect to growth parameters; root collar diameter, height, root depth and survival rate.

Generally, this study concludes that *Anacadium occidentale* watered every two and four days with 80 milliliters, were ensures good growth performance. Such findings therefore have implications on water wastage, reduced labour costs and maximizing profitability of tree seedlings production at nursery. In particular, these results will assist private nursery growers in the propagation of cashew grafted trees.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

[1] Abdul, S. M. and Peter, K, *Cashew-A Monograph*, Studium Press (India) Pvt. Ltd, 2010.

[2] Goujon, P., Lefèbvre, A., Leturcq, P.H., Marcellesi, A.P. and Praloran J.C, Etudes sur l'anacardier, *Revue Bois et Forêts des Tropiques* 151. 27-53. September-October 1973.

[3] Dugué, P., Koné, FR. and Koné, G, Gestion des ressources naturelles et évolution des systèmes de production agricole des savanes de Côte d'Ivoire: conséquences pour l'élaboration des politiques agricoles, *Cahiers Agricultures*, 12(4), 267-273, Mai 2003.

[4] de Oliveira, V.H., de Moura, L.B. and de Lima, R.N.O, Influência da irrigação e do genótipo na produção de castanha em cajueiro-anão-precoce, *Pesq. Agropec. Bras*, 38(1), 61-66, January 2003.

[5] Mng'omba, S.A., Festus, K.A., Gudeta S., Ajayi, O.C., Betserai, I.N. and Ramni, J, Water application rate and frequency affect seedling survival and growth of *Vangueria infausta* and *Persea Americana*, African Journal of Biotechnology, 10(9), 1593-1599, February 2011.

[6] Mukhtar, R.B, Effect of drought stress on early growth of *Adansonia digitata* (L.) in semi-arid region of Nigeria, *Journal of Research in Forestry, wildlife and Environment*, 8(4), 109-115, December 2016.

[7] Verma, R., Kumar, R. and Nath, A, Drought Resistance Mechanism and Adaptation to Water Stress in Sorghum [*Sorghum bicolor* (L.) Moench], *International Journal of Bio-resource and Stress Management*, 9(1), 167-172, January 2018.

[8] Kirnak, H., Kaya, C., Tas, I. and Higgs, D, The influence of water deficit on vegetative growth, physiology, fruit yield and quality in eggplants, *Bulg. j. plant physiol*, 27(3-4), 34-46, September 2001.

[9] Morrison, J., Morikawa, M., Murphy, M., and Schulte, P, Water scarcity & climate change: Growing risks for businesses and investors, in Ceres Report, Ceres, 60p.

[10] Olaoye, B.A. and Oyun, M.B, Early growth of selected indigenous tree species in response to watering regime, *Tropical Plant Research* 6(2), 192-198, July 2019.

[11] Djaha, A.J.B., Adopo, N.A.A., Koffi, K.E., Ballo, K.C. and Coulibaly, M, Croissance et aptitude au greffage de deux génotypes d'anacardier (*Anacardium occidentale* L.) élites utilisées comme porte-greffe en Côte d'Ivoire, *Int. J. Biol. Chem. Sci*, 6(4), 1453-1466, August 2012.

[12] King'oro, M.W., Mushimiyamana, D., Cheserek, J.J. and Gichimu, B.M, Effect of Different Watering Regimes on Agromorphology of Selected Coffee Genotypes, *American Journal of Experimental Agriculture*, 4(9), 1016-1026, April 2014.

[13] Mokhatar, S.J., Daud, N.W. and Zamri, N.M, Evaluation of different water regimes on *Hevea brasiliensis* grown on haplic ferralsol soil at nursery stage, *Am. J. Applied Sci*, 1(3), 28-33, 2011.

[14] Sale, F.A, Evaluation of watering regime and different pot sizes on the growth of *Parkia biglobosa* seedlings under nursery condition, *European Scientific Journal*, 11(12), 313-325, April 2015.

[15] Oyun, M.B., Adedunfan, S.A., and Suberu, S.A, Influence of watering regime and mycorrhizae inoculations on the physiology and early growth of *Acacia senegal* (L.) wild, *African Journal of Plant Science*, 4(7), 210-216, July 2010.

[16] Djoah, Y.T., Minkate, A.N., Nana, D.M., Mbock, M.R., Ngondi, O.T.J., Efombagn, M.I.B. and Ambang, Z, effects of mulching and watering frequency on the growth and development in nurseries of coffee (*Coffea canephora* P. var Robusta) plants produced by direct cutting under plastic-tunnel, *Am. J. innov. res. appl. Sci*, 14(6), 303-311, June 2022.