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Evaluation of Natural Fertilizer Potential of Neem Leaves Aqueous Extract for Irrigation Practices

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ABSTRACT: A natural fertilizer relies on plant, mineral and animal sources for its nutrients. The objective of this paper is to evaluate the natural fertilizer potential of Neem leaves aqueous extract for irrigation practices by analyzing some physicochemical parameters using standard methods. Data obtained shows that the pH level were, 8.4, 7.2, 7.1, and 7.3 respectively indicating a moderate alkalinity status suitable for irrigation. The electrical conductivity values were as 2.4, 2.2, and 1.8 mg/L for Neem aqueous extract while turbidity values were 334, 323, and 296 NTU respectively .These values are within the acceptable range according to FAO guidelines. SAR values were as 11.20, 10.04, and 10.81 and chloride levels were found to be; 22.1, 16.12, and 5.97 mg/L, posing no concerns for irrigation. Sodium levels were 35.7, 27.32 and 25.31 mg/L which also falls within the FAO guidelines and indicating moderate sodicity. Overall, the nutritional compositions of the Neem leaf extracts were within the FAO guideline limits for irrigation fluid, indicating their suitability for irrigation practices. This Neem leaf extract as an irrigation solution could provide a valuable insights for farmers and agricultural practitioners seeking to optimize crop productivity and quality.

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Keywords: Irrigation; Neem leaves; aqueous extract; physiochemical properties

Micro-irrigation is a low-pressure, low-volume system that offers precise control over watering. The system applies directly to the plant's roots, improving irrigation efficiency and ensuring uniform distribution. Water is a crucial component in agricultural production as it serves as the primary input for the growth of plants and animals. The water requirements of plants are typically fulfilled by the presence of soil water stored in the root zone. it expressed that it is crucial to have a sufficient supply of high-quality water that is suitable for crop irrigation in order to monitor and maximize crop production for global food security, particularly in Africa. As a result, there is a significant reliance on untreated water for irrigation purposes. According to Aiyesanmi (2006), water possesses distinctive chemical characteristics due to its polarity and hydrogen bonding, which enable it to dissolve, absorb, or suspend various substances. As a result, water in nature is not pure, as it accumulates contaminants from its surroundings, including those originating from human and animal activities, as well as biological processes. While natural rainfall replenishes soil water under rainfed conditions, irrigation becomes essential to maintain optimal soil water levels for achieving higher crop yields. When the irrigation water is of poor quality, it

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adversely affects crop productivity, the quality of the harvested produce, According to Dhirendra *et al*. (2009),and Amadi et al. (2010) low-quality water and urban effluents has negative influence on water and that optimizing water quality is essential for achieving successful agricultural practices. Plants due to the high content of various bioactive compounds are the main raw material for production of valuable, and useful bio-products such as food, cosmetics, medicines, biostimulants, biopesticides, and feed ad that different plant parts, for instance: seeds fruits, flowers, stems, leaves, and roots can be used for their manufacture (katarzyna et al., 2021). Nowadays, there is a clear need to develop new, efficient, and environmentally safe methods of stimulation of plant, growth and crop protection. According to Hossain et at. (2008) and Subbalashmi et al. (2012) Neem-based products have a wide range of applications, including their use as neem insecticides, neem pesticides, neem fumigants, neem fertilizers, neem manure, neem compost, neem urea coating agents, and neem soil conditioners. The objective of this research therefore is to evaluate the natural fertilizer potential of Neem leaves aqueous extract for irrigation practices by analyzing some physicochemical parameters.

MATERIALS AND METHOD

Description of the study area: The study area (Figure 1) is located at latitude 08^{0} 26' North and longitude 04^{0} 30' East, falling in a transitional zone between the climate of southern Nigeria and the semi-arid Sudan savannah found in the northern region of Nigeria. It lies on the altitude of approximately. The duration of the rainy season in this area lasts for approximately seven months, while the dry season spans about five months (Aminu, 2010).

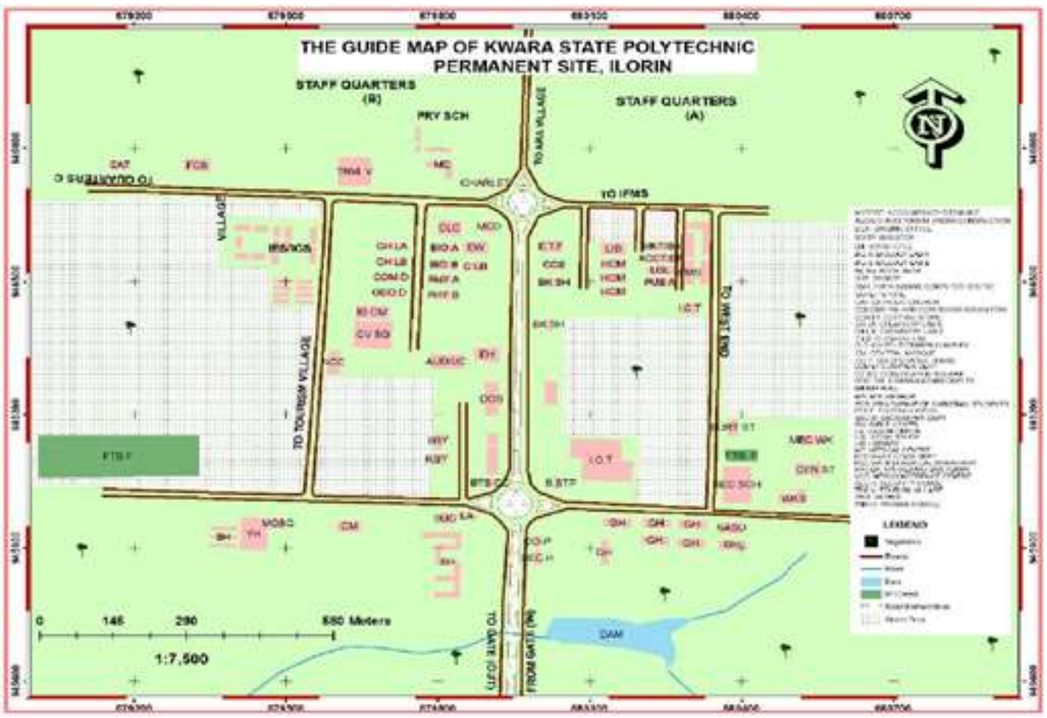


Fig 1: Map of Kwara State Polytechnic where the experimental site is located

Research Methods: Fresh neem leaves weighing 5,7 and 12kg was plugged from the teaching and research farm of Kwara State Polytechnic in Ilorin, Kwara State. The leaves were chopped into small pieces using a knife and then placed in a plastic container containing 50 liters of water. The containers was kept in a shaded area and covered properly. Afterward, the leaves were filtered out using a 2mm sieve to obtain a clean neem leaf extract. The extract was then diluted with 20 liters of water and allowed to soak for a period of 30 days to facilitate the formation of maggots and borehole water was used as a control.

Neem Leaves Extract Analysis Method: The physical and chemical properties of the neem leaf extract samples were evaluated for irrigation purposes. The analysis followed standard methods and procedures outlined by the American Public Health Association (APHA) in 2004 and the Food and Agriculture Organization (FAO) in 2013 was used to compare the result of the analysis.

Physical Analysis: Physical analysis involves evaluating physical properties such as color, turbidity, and temperature. To assess colour, the neem leaf extract was visually compared to a series of platinum-cobalt standards in Nessler tubes. Turbidity was determined using nephelometric turbidity units (NTU), while temperature measurements of the neem leaf extract samples were obtained using a clinical thermometer.

Chemical Analysis: The following methods were employed for the analysis:
The pH of the neem leaf extract samples was determined using a glass electrode pH meter.
The electrical conductivity of the extract was measured using a conductivity meter.
The levels of exchangeable magnesium (Mg), calcium (Ca), and sodium (Na) were determined using a flame analyzer.
The (ESP) was calculated using the ammonium acetate (NH4OAC) method.
The exchangeable acidity was determined by titrating the filtration with potassium chloride and sodium hydroxide, with phenolphthalein used as an indicator.
The available phosphorus content was determined using the Bray I method.
The total nitrogen content was determined using a modified micro Kjeldahl method.
The Sodium adsorption ratio (SAR) was calculated using a given expression.

$$\mathrm{SAR} = \frac{Na^{+}}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Where: SAR = Sodium adsorption ratio (meg/l); Na = Sodium (me/l); Ca = Calcium (me/l); Mg = Magnesium (me/l)

RESULTS AND DISCUSSIONS

The Table 1 shows the results of the physiochemical properties analysis of Neem leaves compared with the standard of FAO after the experiments

Table 1: The Results of the Physio-Chemical Properties Analysis of Neem leaves

	Parameters	**Neem 1**	**Neem 2**	**Neem 3**	**Average**	**Control Borehole water**	**FAO**
1.	Temperature	29.2	28.9	29.1	29.1		
2.	Colour (TCU)	4.0	3.97	3.88	3.95	4.0	
3.	Turbidity (NTU)	334	323	296	317	311	0-450
4.	Electrical Conductivity(dS/cm)	2.4	2.2	1.8	2.1	1.6	0-3
5.	pH	8.4	7.2	7.1	7.5	7.3	6.0-8.5
6.	Calcium, Ca^{2+} (mg/L)	16.50	12.41	8.57	12.49	12.61	0-20
7.	Magnesium, Mg^{2+}(mg/L)	3.40	2.36	2.41	2.72	2.30	0-5
8.	Chloride(mg/L)	22.21	16.12	5.79	14.70	12.03	0-30
9.	Nitrite (mg/L)	19.23	19.20	19.3	19.24	19.23	
10.	Nitrate (mg/L)	15.62	15.37	15.38	15.46	15.62	
11.	Sodium (mg/L)	35.27	27.32	25.31	29.3	23.20	0-40
12.	Potassium (mg/L)	1.20	1.12	1.45	1.26	1.52	0-2
13.	Sulphate, (mg/L)	9.32	6.23	5.21	6.92	6.32	0-20
14.	Phosphate (mg/L)	0.94	0.87	0.83	0.88	0.94	
15.	Boron	1.4	1.2	1.1	1.23	1.42	0-2
16.	SAR	11.20	10.04	10.81	10.68	8.63	0-15

The result (Tale 1) analysis for sample the values obtained for Turbidity (NTU) of the three samples ware, 334, 323, and 296 respectively, pH of 8.4 7.2 , 7.1, the Magnesium (Mg) content result on the three Neem samples are 3.40 2.36 and 2.41 mg/l respectively, Potassium content in each of the Neem are respectively 1.20 1.12 , and 1.45mg/l, Total hardness are 97 , 82 and 62 mg/l respectively, Ion values are 3.72, 2.61 and 2.96 mg/l respectively, calcium of 16.50 , 12.41 and 8.57 mg/l were present in the neem sample respectively, Chloride of 22.21 16.12 , 5.79 mg/l respectively, Sulphate of 9.32 , 6.23 and 5.21 mg/l respectively Sodium 35.27 27.32, and 25.31 mg/l and Electrical conductivity (EC) 2.4 , 2.2 and 1.8mg/l.

Salinity: Salinity in neem leaf extract for irrigation can be accessed through the measurements of Electrical Conductivity (ECW) and Turbidity. The electrical conductivity values for the neem samples were 2.4, 2.2 , and 1.8 mg/L respectively, while the turbidity values were 334 , 323 , and 296 NTU respectively. Figure 1 and 2 show the relationship between the FAO standard and the values of the electrical conductivity (ECW) and Turbidity of Neem extract,and control (Borehole) from the analyses .By comparing these values with the FAO guidelines for irrigation neem extract quality, it can be concluded that the electrical conductivity falls within the range that imposes no restrictions on usage, indicating low to moderate salinity. Additionally, the turbidity values of all three neem samples fall within the "no restriction on use" category as per the FAO standard limits. Therefore, the neem leaf extract is considered suitable for irrigation practices.

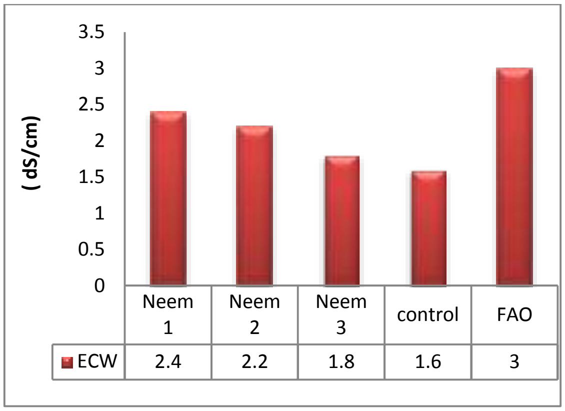


Fig 1: Salinity of Neem extract

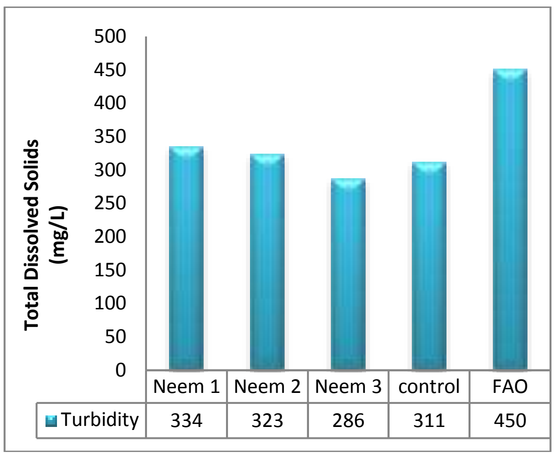


Fig 2: Salinity of Neem extract

Infiltration: When water quality is poor, an infiltration problem can arise, leading to a significant reduction in the normal rate at which water is absorbed by the soil. This results in water remaining on the soil surface for an extended period or infiltrating too slowly to adequately supply the crop with the necessary water for optimal yields. The evaluation of infiltration problems can be done by considering the Electrical Conductivity of water (ECw) and the Sodium Adsorption Ratio (SAR), as outlined by the FAO in 2013. The calculation of SAR involves parameters such as Sodium, Magnesium, and Calcium, as indicated in Table 2. The calculated SAR values for neem samples 1, 2, and 3 are 11.20, 10.04, and 10.81, respectively. Figure 3 show the relationship between the FAO standard and the values of Electrical Conductivity of water (ECw) and the Sodium Adsorption Ratio (SAR), of the Neem extract, and control (Borehole) from the analyses comparing the ECw and SAR values with the FAO standard limits, it is determined that all three samples fall within the acceptable limit category. Therefore, there are no restrictions on the use of neem leaf extract for irrigation practices, making it suitable for such purposes.

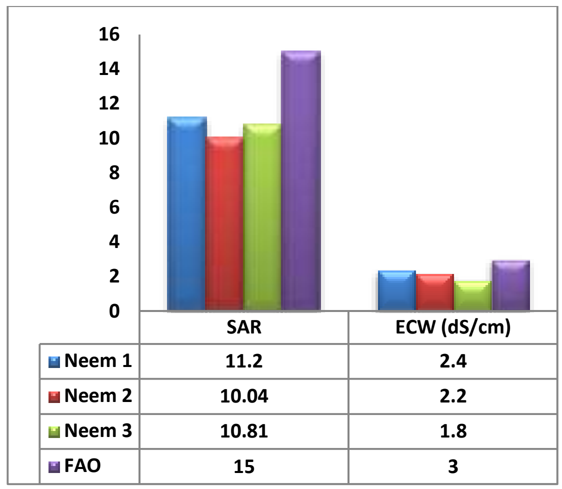


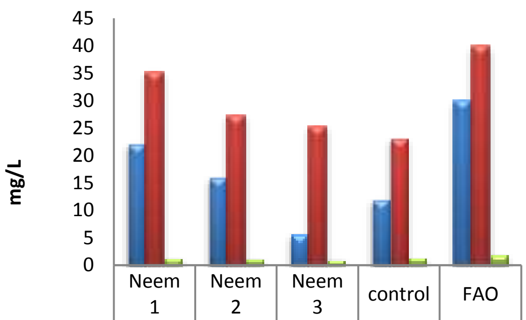
Fig 3 Infiltration of neem extract

Toxicity: Toxicity issues can arise in crops when certain ions are present in sufficient quantities, depending on the sensitivity of the crop and the duration of exposure. Perennial crops are particularly susceptible to toxicity problems. In irrigated agriculture, the main ions of concern are Chloride (Cl-), Sodium (Na+), and Boron (B). Figure 4 show the relationship between the FAO standard and the values of Chloride (Cl-), Sodium (Na+), and Boron (B) of the Neem extract, and control (Borehole) .The analysis results indicate that the Chloride levels in water samples 1, 2, and 3 are 22.1, 16.12, and 5.97 mg/L, respectively.

Table 2 Calculation of SAR for sample 1, 2 and 3

SAR for Sample 1	SAR for Sample 2	SAR for Sample 3
$SAR = \frac{\text{Na}}{\sqrt{\text{Ca} + \text{Mg}/2}}$	$SAR = \frac{\text{Na}}{\sqrt{\text{Ca} + \text{Mg}/2}}$	$SAR = \frac{\text{Na}}{\sqrt{\text{Ca} + \text{Mg}/2}}$
Substitution;	Substitution;	Substitution;
$SAR = \frac{35.27}{\sqrt{3.40 + 16.50/2}}$	$SAR = \frac{27.32}{\sqrt{2.6 + 12.4/2}}$	$SAR = \frac{25.31}{\sqrt{2.41 + 8.57/2}}$
$SAR = 11.20$	SAR.=10.04	SAR.=10.81

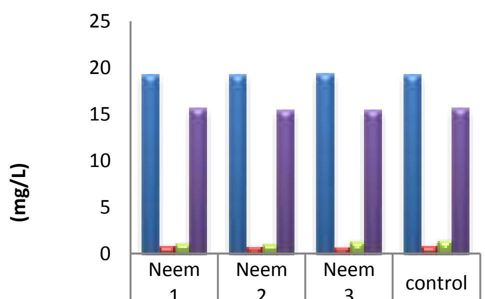
These levels fall within the FAO standard limit, indicating that they do not pose a problem for irrigation practices. However, the sodium levels in sample 1, 2, and 3 are 35.27, 27.32, and 25.31 mg/L, respectively. These levels also fall within the FAO guideline limit, indicating moderate toxicity. Despite the moderate toxicty, the neem leaf extract is still suitable for irrigation practices.



	Neem 1	Neem 2	Neem 3	control	FAO
Chloride	22.21	16.12	5.79	12.02	30
Sodium	35.27	27.32	25.31	23.2	40
Boron	1.4	1.2	1.1	1.42	2

Fig 4: Toxicity of neem extract

*Nutrients***:** Various components, such as Nitrate, Phosphorus, and Potassium levels, play a crucial role in irrigation water. Nitrogen levels can be measured in terms of Nitrate (NO3-N) and Ammonium (NH4-N), as well as the electrical equivalent of available nitrogen in the water. Phosphate (PO4-P) levels can be expressed as equivalent elemental phosphorus. Figure 5 show the relationship between the FAO standard and the values of the Nitrite, Nitrate, phosphate, potassium of Neem extract, and control (Borehole) . The analysis results indicate that the nutritional compositions of all neem leaf extracts fall within the FAO guidelines and are suitable for irrigation practices.



	Neem 1	Neem 2	Neem 3	control
Nitrite	19.23	19.2	19.3	19.23
Phosphate	0.94	0.87	0.83	0.94
Potassium	1.2	1.12	1.45	1.52
Nitrate	15.62	15.37	15.38	15.62

Fig 5: Nutrient of neem extract

Conclusions: Based on the data obtained, the pH values of Neem samples indicates moderate alkalinity status of the soils, making them suitable for irrigation. The electrical conductivity and turbidity values fall within the FAO guidelines for irrigation Neem extract with low to moderate salinity and have no restrictions on use, making the Neem leaf extract suitable for irrigation practices. Sodium Adsorption Ratio (SAR) values also indicates no restrictions on the use of Neem leaf extract for irrigation purposes. While, chloride levels, sodium levels, and nutritional compositions of all Neem leaf extracts are within the FAO guidelines, making them suitable for irrigation practices.

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