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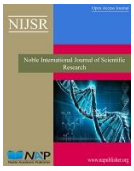

Original Article **Open Access**

Effect of Different Nitrogen Fertilizer Types on Growth Yield and Gel Composition of Aloe Vera

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Abstract: Aloe vera is a natural product that is now frequently used in the field of cosmetology. Though there are various indications for its use, controlled trials are needed to determine its real efficacy. Therefore this research was conducted to determine the effects of different nitrogen sources on growth, yield and gel composition of Aloe vera. A pot experiment was conducted at screen house of the Faculty of Agricultural Sciences Ladoke Akintola University of Technology Ogbomoso, Nigeria. The treatment comprises of thirteen different Nitrogen fertilizer sources (Urea 62.5 kgN/ha and 125 kgN/ha, NPK 62.5 kgN/ha and 125 KgN/ha, Tithonia 62.5 KgN/ha and 125 kgN/ha, Feedstock 62.5 KgN/ha and 125 kgN/ha, Deep litter 62.5 kgN/ha and 125 kgN/ha, Goat manure 62.5 KgN/ha and 125 kgN/ha) and control. Aloe vera was laid out in a complete randomized design with four replications. The parameters measured and recorded were leaf length, leaf width, plant height, Number of suckers, Number of leaves, leaf thickness, leaf volume and gel composition. After fifteen months of transplanting, the Aloe vera plant was harvested, washed with distilled water and blended and taken to laboratory for analysis. Result showed NPK applied at the rate of 62.5 KgN/ha increased the leaves length, width, thickness and plant height, Tithonia applied at the rate of 125 Kg N/ha increased the number of leaves, Number of sucker, and volume of leaves, it was also observed that the Deep litter at that rate of 125 KgN/ha, NPK at the rate of 125 KgN/ha, Feedstock at the rate of 62.5KgN/ha and 125 KgN/ha increased the phytochemical composition of Aloe vera. In conclusion NPK at the rate of 62.5 KgN/ha is recommended for growth and yield. Tithonia at the rate of 125 KgN/ha is recommended for immune boosting, anti-inflammatory, analgesic, antibacterial and antiviral. While for antiseptic, Deep litter at 62.5 KgN/ha, for antioxidant, Feedstock at 62.5 KgN/ha and 125 Kg/ha and NPK application at 125KgN/ha were recommended for formation of bones and teeth.

Keywords: Nitrogen, Fertilizer Types, Aloe Vera, Phytochemical.

1. Introduction

Aloe vera L. is an important member of Liliaceae family and genus Aloe [1, 2]. It is widely cultivated in many countries due to its importance as an all-purpose herbal or medicinal plant. The plant is sometimes referred to as a "miraculous plant", 'the wonder plant', 'plant of immortality' and 'nature powder' [3, 4]. It is a shrubby or arborescent, perennial, xerophytic, succulent, pea- green color plant and has been used in dermatology [5].

Aloe vera leaves has seventy-five active constituents but the most documented are: 20 minerals, 20 amino acids, 12 vitamins, and water [6]. The leaves of this plant contain fat compounds, carbohydrates, proteins, lipids, and 18 essential amino acids, vitamins (e.g., A, C, E, vitamin B12, folic acid), minerals, glycoprotein, C-glucosylchromone, anthraquinones, emodin, salicylic acid and various kinds of enzymes [3, 7, 8]. Also contained in the plant are secondary metabolites including alkaloids, aloins, lectins, lignin, saponins, tannins, phenolic and glukomannan are also present in the plant [9, 10].

The cultivation of *Aloe vera* has gained great commercial importance for medicinal products and cosmetics processing. Its cultivation is expanding as it provides quick and regular income to the farmers

[11], use as functional food supplement and preservative of foods due to the presence of antioxidant molecules, high amount of carbohydrates, and vitamins as its constituents [12].

Aloe gel have been reported to improve wound healing [7], reduces severe joint and muscle pain associated with arthritis, as well as pain related to tendinitis and injuries [13], the leaves of *Aloe* are eaten as vegetable, cosmetic companies add sap or other derivatives from *Aloe vera* to products such as makeup items, moisturizers, soaps, sunscreens, shaving cream, and shampoos [14], cosmetology and medicine [2-4, 7, 15], used for the perturbation of enzymatic and nonenzymatic antioxidative indices levels in rats [16, 17].

Nitrogen (N) is a key nutrient for plant growth and play vital role in plant biochemical processes associated with amino acid, protein, enzymes, and chlorophyll molecule [18]. In soil, nitrogen enhancing plant growth will result in increase in leaf area and number of leaves and having direct impact on vegetative and reproductive phases of plants [19-22]. In the atmosphere, by composition N is the largest and yet remains the most limiting in most of the plants. The natural soil N input mechanism does not significantly support food production globally as there is a continuous population growth [23], therefore, the use of N from synthetic fertilizer sources is highly necessary. Nitrogen generally determines crop yield and when applied in excess, will lead to low N use efficiency (NUE).

2. Materials and Methods

The experiment was carried out between June 2020 to September 2021 at the screen house of Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, located on longitude 4° 30'E and latitude 10° 5'N. The experimental design used was Completely Randomized Design (CRD). The treatment consisted of six (6) fertilizer source (NPK, Urea, Tithonia, goat manure, feed stock and poultry manure) and applied at 125 and 62.5 kg N/ha according to [24] recommendation and replicated four times. Fertilizer was applied a month after transplanting. Soil samples were collected for pre-cropping physical and chemical routine analyses [25].

The pots were prepared using plastic bowls, each filled with 10 kg soil. Data were observed and recorded on growth (Leaf length, Plant height, Leaf width, Leaf thickness), Yield (Number of Suckers, Number of leaves, Leaf volume), Phytochemicals: Sugars (Fructose, Glucose), Anti-inflammatory (Antraquinone), Antiseptic (Saponin, Steroids), Minerals (Calcium, Iron)

All data generated were subjected to analysis of variance in a complete randomized design and significant means were separated using Duncan's multiple range test (DMR) at 5% probability level.

3. Results

3.1. Physical and Chemical Analysis of Experimental Soil

Result of soil physical and chemical analysis is shown in table 1. The result showed that soil of the experimental site has very low nitrogen, low organic carbon and high available phosphorus. The pH of the soil is neutral. The micro-nutrient, iron, zinc and manganese are very high while copper is high. The exchangeable cation (K, Mg, Ca, Na) were medium. The textural class of the soil is loamy.

3.2. Growth Parameter of *Aloe Vera* As Influenced By Different Nitrogen Fertilizer Source

The leaf length of *Aloe vera* as influenced by different Nitrogen sources is shown in Table 1. Pots with applied Urea at 62.5 KgN/ha (35.60cm), Deep litter at 125KgN/ha (33.70cm) and 62.5KgN/ha (33.17cm), NPK at 62.5KgN/ha (35.20cm), Tithonia at 125KgN/ha (34cm) and 62.5KgN/ha (34.63cm), Feedstock at 125KgN/ha and 62.5KgN/ha (33.70cm) and those with Goat manure at 62.5KgN/ha (34.60cm) and at 62.5KgN/ha (34.60cm) produced longer leaves at 15 month after transplanting compared to Goat manure at 125 KgN/ha (27.17cm) with shorter leaves. The longest and shortest leaves were not significantly different from the plant with no application (31.07cm).

At 15 month after transplanting, pots with applied NPK at 62.5KgN/ha (5.43cm), Feedstock at 125KgN/ha (5.50cm) and Goat manure at 125KgN/ha (5.45cm) produced wider leaves which is not significantly different from plant without application. Goat manure at 125KgN/ha (4.75cm) and NPK at 125KgN/ha (4.73cm) produced narrow leaves.

Pots with applied Tithonia at 125KgN/ha (12.20cm) produced thicker leaves which is significantly different from pots with no application compared to Goat manure at 125 KgN/ha (8.85cm) with the thin leaves.

Table 1. Particle Size Distribution and Chemical Properties of Soil before Cropping

Parameters	**Value**
pH (H_2O)	6.50
Organic carbon (g Kg^{-1})	0.55
Total Nitrogen (g Kg^{-1})	0.05
Available Phosphorus (mg Kg^{-1})	10.59
Exchangeable cations (cmol Kg^{-1})	
K	0.17
Ca	3.39
Mg	0.40
Na	0.08
Micronutrients (mg Kg^{-1})	
Fe	273.87
Mn	150.20
Cu	6.79
Zn	198.80
Particle size distribution (g Kg^{-1})	
Sand	82
Silt	5
Clay	12
Textural lass	

Source: Authors

Table 2. Effect of different nitrogen fertilizer treatment on growth of *Aloe vera* at different month after transplanting Means having the same letter within a column are not significantly different using duncan multiple range test at 5% probability level.

At 15 month after transplanting				
Treatment KgN/ha	**Leaf length**	**Plant height**	**Leaf width**	**Leaf thickness**
Control	31.07ab	36.67abc	4.87ab	9.82bc
Urea 125	29.92ab	36.15ab	4.90ab	9.45ab
Urea 62.5	35.60b	39.25bc	5.35ab	10.67bcd
NPK 125	30.35ab	36.07ab	4.72a	9.60abc
NPK 62.5	35.02b	43.22c	5.42b	11.50de
Tithonia 125	34.00b	42.15bc	5.27ab	12.20e
Tithonia 62.5	34.62b	40.15bc	5.25ab	10.27bcd
Deep litter 125	34.20b	40.72bc	5.27ab	10.75bcd
Deep litter 62.5	33.17b	35.60ab	5.27ab	10.45bcd
Feedstock 125	32.32b	38.77bc	5.50b	10.92cde
Feedstock 62.5	33.70b	40.00bc	5.30ab	10.22bcd
Goat manure 125	27.17a	31.57a	4.75a	8.35a
Goat manure 62.5	34.60b	37.60abc	5.45b	10.52bcd

Source: Author

3.3. Yield Parameter of *Aloe Vera* As Influenced by Different Nitrogen Sources

There was no significant effect of the applied nutrients at 9 months after transplanting (Table 2). However at 15 months, pots with applied Tithonia at 125 KgN/ha (18) and pots with applied Urea at 62.5 KgN/ha (18) produced more leaves compared to pot with applied Goat manure (14) with fewer leaf production.

There was no significant difference in the applied treatment at 6 months after transplanting Pots with applied Tithonia at 125 KgN/ha produced highest numbers of suckers (22) at 15 month after transplanting which is significantly different from pots with no application. Goat manure applied at 62.5 KgN/ha (7) led to the production of fewer number of suckers.

Pots with applied NPK at 62.5 KgN/ha (577cm^3)and Tithonia at 125 KgN(572.6^3) produced the highest volume of leaves compared to Goat manure at 125 KgN/ha which produced the lowest volume of leaves (296cm^3).The pots with no applied treatments were not significantly different from the plants with the highest and lowest volume of leaf.

Table 3. Effect of different nitrogen fertilizer treatment on yield of *Aloe vera* at different month after transplanting Means having the same letter within a column are not significantly different using duncan multiple range test at 5% probability level.

At 15 month after transplanting			
Treatment KgN/ha	**Number of leaves**	**Number of suckers**	**Leaf volume**
Control	17abc	20cd	412.3ab
Urea 125	17bc	9ab	365.4ab
Urea 62.5	18c	18bcd	526.7bc
NPK 125	15abc	13abc	364.1ab
NPK 62.5	16abc	18bcd	577.0c
Tithonia 125	18c	22d	572.6c
Tithonia 62.5	16abc	10ab	494.1bc
Deep litter 125	16abc	10ab	534.0bc
Deep litter 62.5	14ab	12abc	486.7bc
Feedstock 125	15abc	12abc	528.2bc
Feedstock 62.5	15abc	18bcd	485.4bc
Goat manure 125	14a	7a	296.0a
Goat manure 62.5	15abc	11abc	520.6bc

Source: Author

Table 4 present the percentage concentration of sucrose, fructose ,saponin, steroids, Anthraquinone, iron and Calcium of *Aloe vera* as influenced by different Nitrogen fertilizer.

Pots with applied Deeplitter 125 KgN/ha contained the highest concentration of sucrose, fructose, anthraquinone, Iron, Meanwhile pots with applied Urea at 125KgN/ha contained the highest concentration of steroids, pots with applied NPK at 125 KgN/ha contained the highest concentration of saponin, pots with applied feedstock at 125KgN/ha contains the concentration of calcium while control (pots without application) has the lowest concentration of sucrose, steroids, frutose, Anthraquinone. Also, pots with applied NPK at 62.5 KgN/ha contain the lowest concentration of calcium, iron, and pots with applied Tithonia 62.5 KgN/ha contains the lowest concentration of saponin.

Table 4. Effect of different nitrogen fertilizer on phytochemicals at different month after tran splanting Means having the same letter within the same column are not significantly different using Duncan multiple range test at 5% probability level.

	SUCROSE %	STEROID %	SAPONIN %	FRUCTOSE %	ANTHRAQUINONE %	Ca/mg/100sml	Fe/mg/100ml
Control	4.31a	10.17a	29.68c	4.93a	7.16a	1.36d	1.27d
Urea 125	7.64c	19.18f	53.10k	7.56b	13.12f	1.74j	1.35e
Urea 62.5	5.60b	17.18def	45.20h	5.21a	12.26e	1.37e	1.26c
NPK 125	7.64c	16.05cde	53.61m	16.71e	15.14i	1.76k	1.22b
NPK 62.5	10.95e	14.02c	52.05i	13.51d	14.52h	1.15a	1.00a
Tithonia 125	23.02k	15.60cde	32.72e	26.30g	14.91i	1.67h	1.68h
Tithonia 62.5	8.53d	15.26cd	24.26a	11.53c	11.03c	1.52f	1.43f
Deep Litter 125	25.02l	18.44ef	53.35l	27.12g	17.23k	1.71i	2.02l
Deep Litter 62.5	14.41g	19.22f	52.73j	20.04f	13.59g	1.20b	1.22b
Feedstock 125	12.36f	15.35cd	30.16d	14.98de	13.38j	1.87l	1.76i
Feedstock 62.5	7.49c	10.72ab	27.18b	11.32c	11.63d	1.87l	1.67g
Goat Manure 125	20.58j	18.13def	39.89g	25.50g	15.15i	1.56g	1.88k
Goat Manure 62.5	14.94h	13.11bc	36.75f	15.23de	9.63b	1.33c	1.77j

Source: Author

4. Discussion

Plant that are effective in absorption and utilization of the absorbed nutrient is greatly enhanced by the efficiency of the applied fertilizer [26]. It is expected that a higher and balanced nutrient supply will result in higher yield of *Aloe vera*.

Therefore, there is need to understand the amount of applied and type of fertilizer that will give the best output for farmers and to formulate economical markets. Application of NPK at the rate of 62.5 KgN/ha and Tithonia 125 KgN/ha resulted in the higher performance of most of the growth and yield of *Aloe vera* respectively compared to other treatments. However, leaf length of *Aloe vera* was higher when fertilized with Urea at rate of 62.5 KgN/ha, this was supported by [27] in which Urea 50 and 75 KgN/ha application rates increase leaf length of *Aloe vera* from(17.21cm) to (18.82cm) as compared to control. At 15 months after transplanting, Urea 62.5 KgN/ha and Tithonia 125 KgN/ha have the highest number of leaves per plant which differed significantly from other treatments. There was also significant increase in suckers number and volume of leaves with the application of Feedstock 62.5 KgN/ha at 7-12 month while the number of sucker production was more than double at the end of 14 month in pots applied with Tithonia at 125 KgN/ha. Previously, it has been observed that the average sucker numbers yield of Aloe vera were significantly increased with the increased in the doses of Nitrogen from feedstock and poultry manure and better results was obtained from different doses of Feedstock than poultry manure.

For plant height, the tallest plant (43.22cm) was identified from pots treated with NPK 62.5 KgN/ha, leaf thickness and leaf width also produced the thickest and widest leaf at NPK applied at 62.5 KgN/ha which may be related to the fact that this NPK promotes the reversible catalytic enzymatic hydrolysis reactions associated with plant growth. The lack of consistency in the response of *Aloe vera* growth and development of growth parameters over time may be associated with development stages of plant, since it has been reported that the difference in stress response is based on the phenological stage which the plant is found and mineralization process that involves the contribution of some macro and microelements [28].This result was also corroborated with the reports of [29] that shows increased in plant height with application of NPK 75KgN/ha fertilizer, which was also in agreement with finding of [30] who reported highest plant height through application of 50%N and 100%PK in onion.

However analysis of nutrient components in *Aloe vera* gel show that Deeplitter 125KgN/ha gives the highest effect on Sugars (Sucrose and Frutose), Anthraquinone and Iron which is also a good source of antioxidants, immune boosting, antiinflammatory and bone formation, Urea 125 KgN/ha and Deeplitter 62.5KgN/ha is a good source for steroids which is an antiseptic while NPK 125 KgN/ha gave the highest effect on Saponin a cleansing agent and finally, Feedstock 125 and 62.5KgN/ha produced highest effect on Calcium for carbohydrates metabolism. This result was supported by [31] that application of Nitrogen Fertilizer led to the substantial amount of nutrient composition in gel of *Aloe vera*, Many reporters also found that increased in application of N fertilizer enhanced composition of *Aloe vera* which was performed by [32] in which the application of NPK and Urea at 200KgN/ha had the highest effect on Steroids, Anthraquinone, Saponin, Sugars and minerals.

5. Conclusion and Recommendation

5.1. Conclusion

At the end of the study, NPK applied at the rate of 62.5 KgN/ha increased the leaf length, leaf width, lead thickness and plant height, Tithonia applied at the rate of 125 KgN/ha increased the number of leaves, Number of sucker, and volume of leaves, it has also been observed that the Deeplitter at that rate of 125 KgN/ha, NPK at the rate of 125 KgN/ha, Feedstock at the rate of 62.5 KgN/ha and 125 KgN/ha increased the phytochemical composition of *Aloe vera*.

5.2. Recommendation

However it has been concluded that NPK at rate of 62.5KgN/ha is recommended for plant growth, and plant yield. Tithonia at the rate of 125KgN/ha is recommended for immune boosting, anti-inflammatory, analgesic, antibacterial and antiviral. Deep litter at 125KgN/ha is recommended for antiseptic, NPK at 125KgN/ha is recommended for formation of bones and teeth, Feedstock at 125and 62.5 KgN/ha are recommended for antioxidant.

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