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Growth, yield and nutrients potentials of *Vigna unguiculata* (L.) Walp as influenced by water regimen

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ABSTRACT

Effects of different concentrations of water were evaluated on growth performances and nutrient potentials of *Vigna unguiculata*. The concentrations of water used for the study were 25ml, 50ml, 100ml and 150ml with application of once and twice daily. The study show that 50ml concentration of water twice daily significantly $P<0.05$ enhanced the growth performances and nutrient potentials of *Vigna unguiculata*. The nutrient composition show that the leaf of *Vigna unguiculata* has carbohydrates, caloric value and protein contents of 62.99%, 365.97% and 17% respectively. The anti-nutrients composition analysis revealed that hydrocyanide content was 9.30mg/100g, Phytate 29.40mg/100g, Oxalate 255.20mg/100g, tannin 23.48mg/100g and Vitamin A and C contents of 6.36mg/100g and 34.05 mg/100g respectively. Mineral elements analysis show that the contents of potassium, sodium and calcium were 208.52mg/100g, 126.14mg/100g and 236.11 mg/100g respectively. This study therefore show that *Vigna unguiculata* contain a

high concentration of energy which represent a balanced source of macro and micro nutrients and can be seen as a potential source of useful items for food formulation.

Article Keywords: Growth, yield, water, regimen.

1. INTRODUCTION

Water is one of the most common substances in the world. It occupies about 75% of the earth surface. The importance of water to man cannot be overemphasized, going by its effects and necessity. And it would be correct to say without water, both man, plants and animals cannot survive or live. Sutcliffe (1999) reported that the total weight of plant constitute as much as about 95% of water, a constituent of protoplasm. Through precipitation mainly rainfall, liquid water is made available to plants as surface water, soil moisture or groundwater. It comprises 70-90% of the body or even more on fresh weight basis, although only a small fraction of the water absorbed is utilized. Most of the absorbed water in plants is lost through transpiration and only about 1 percent or less is used in the various biochemical processes (Delvin, 1975; Mader, 1993).

Water serves as a transport medium for mineral nutrients from the soil, as well as in the translocation of organic substances within the plant, it is a chemical reactant in photosynthesis hence it is vital to life. It is a product of respiration. It is also believed responsible or at least contributing to the cooling of plants through the process of transpiration. Like man, plants can lose their strength, enzyme, shape or life, if they do not secure enough amount of water, however as with other climatic factors, water can possibly cause unfavourable effects on plant growth and development. Excess water in the soil can injure flood prone plants due to lack of oxygen. In this case water stress due to flooding means oxygen stress by deficiency(hypoxia) or total absence (anoxia).The state of water in a soil or water content of a soil explains better why the leaves of plants growing in it becomes wilted and remain so until additional water is added. This condition is what Sutcliffe called the permanent wilting percentage PWP (Sutcliffe, 1999).

Excess water within the plant can also cause injury. Edmond *et al*., (1978) explained that under conditions that favour high absorption and low transpiration rates, there is a buildup of high turgor pressure in the region of cell elongation which causes maximum swelling of the cells.

The quality and purity of water also relates to its importance as acid rain caused by dissolved sulphuric acid and nitric acid that are formed in the air from sulphur dioxide and nitric oxide generated by power plants, smelters, other industrial plants, factories and cars can seriously injure plants (Miller, 2001).

Vigna unguiculata (L.) Walp, commonly called cowpea or "beans" is of the family Fabaceae (Sagar Patel and Hetalkumar Panchal, 2014). It is the most economically important indigenous African legume and most versatile African crop which feeds people, their livestock, the soil and other crops (Onuk et al. 2018). An annual herb which has a growth form that varies; it can be bushy, trailing, erect or climbing. Cowpea (*Vigna unguiculata*) is one of the several species of the widely cultivated genus vigna. Four subspecies are recognized; of which three are cultivated (more exist, including *V. textillis, V. pubescense, and V. sinensis* (Tarawali *et al*., 1997). Cowpea is a warm season, annual, herbaceous legume. Plant types are often categorized as erect, semi-erect, prostrate (trailing), or climbing. There is as much variability within the species (Stark, 2014). Growth habit ranges from intermediate to fairly determinate .Cowpea generally is strongly tap rooted. Root depth has been measured at 95 in 8 weeks after seeding. Cowpea seeds ranges in size from the very small wild types up to nearly 14 in length and the number of seeds per pounds range from 1600 to 4300 (Department of Agriculture, Forestry and fisheries, 2013).

2. MATERIALS AND METHODS

Sources and collection of seeds

The treated seeds of cowpea (*Vigna unguiculata*) were obtained from the Rumuodomaya divisional farm under the Agricultural Development Programme (ADP) of the Rivers State Ministry of Agriculture. The loamy soil samples were obtained behind the Botanical garden, Akwalbom State University.

Study area

The field experiment was carried out in the Green House, Department of biological Sciences (Botany unit), Akwalbom State University.

Soil analysis

Soil analysis was carried out in Soil Science laboratory, Department of Soil Science, Akwalbom State University.

Viability, Germination and Growth Studies

Viability of 3 replicates of 26 seeds was assessed using the tetrazolium chloride (TZ) staining technique (ISTA, 2003). Seeds were placed in 1% tetrazolium chloride solution at 30°C and darkness for 24 hours. Seeds were then cut in half and examined. Only uniformly stained red/dark pink embryos were considered 'viable'.

Seed planting/water regimen

Four seeds of *Vigna unguiculata* were planted in each planting bag in a conducive environment and exposed to the same environmental conditions such as rainfall and sunlight. The planting bags were perforated to drain out water and prevent water logging that may chock plants to death.

The seeds germinated on the third day after planting and water treatment followed immediately on the fourth day. Different water treatments of 25ml,50ml, 100ml, 150ml, and a control treatment of 0ml were applied twice daily to the seeds planted in 20 of the planting bags under group A, while the same amount of water regime treatments were applied once daily to seeds planted in the other 20 planting bags under group B.

Germination percentage

After the seedlings sprouted, the germination percentage was calculated per bag for the different treatments by observing the number of seeds that sprouted per bag over the total number of seeds planted in that bag multiplied by 100.

Measurement of growth parameters

The growth parameters measured included plant height, leaf length, leaf width, number of leaves, leaf area, fresh weight and dry weights.

Determination of nutrient and anti-nutritive substances

The proximate composition, mineral elements contents, anti-nutrients and vitamins were determined according to the methods of AOAC (1984).

Statistical analysis

The use of statistics was employed using the analysis of variance (ANOVA) in order to determine the effects of different water treatments on plant height, number of leaves, leaf length/width, leaf area, fresh and dry weight of *Vigna unguiculata* from the first week of planting to the 12th week of planting.

3. RESULTS

The result of the physicochemical properties of the experimental soil shows that pH was 4.40, ECEC 22.126 Cmol/kg, clay 14.0%, sand 64.6% (Table 1).

Table 1 Physicochemical properties of the experimental soil

PH (1:1) H_2O	% Oc	%N	Mg/g	Cmol/kg Ca	Cmol/kg Mg	Cmol/kg k	Cmol/kg Na	Cmol/kg Acidity	Cmol/kg Al	Cmol/kg ECEC	% Clay	% Salt	% Sand
4.40	2.505	0.260	42.711	20.362	0.62	0.091	0.692	0.32	0.00	22.126	14.0	21.4	64.6

Germination and Growth Studies

Therewas 100% germination recorded when the treated with 50ml of water twice daily and there were significant ($p<0.05$) increase in the plant height, number of leaves, leaf width, fresh weight and dry weight when treated with 50ml of water twice daily (Figures 1, 2, 4, 5 and 6). The leaf length and leaf area were significantly enhanced when treated with 25ml of water (Figures 3 and 7).

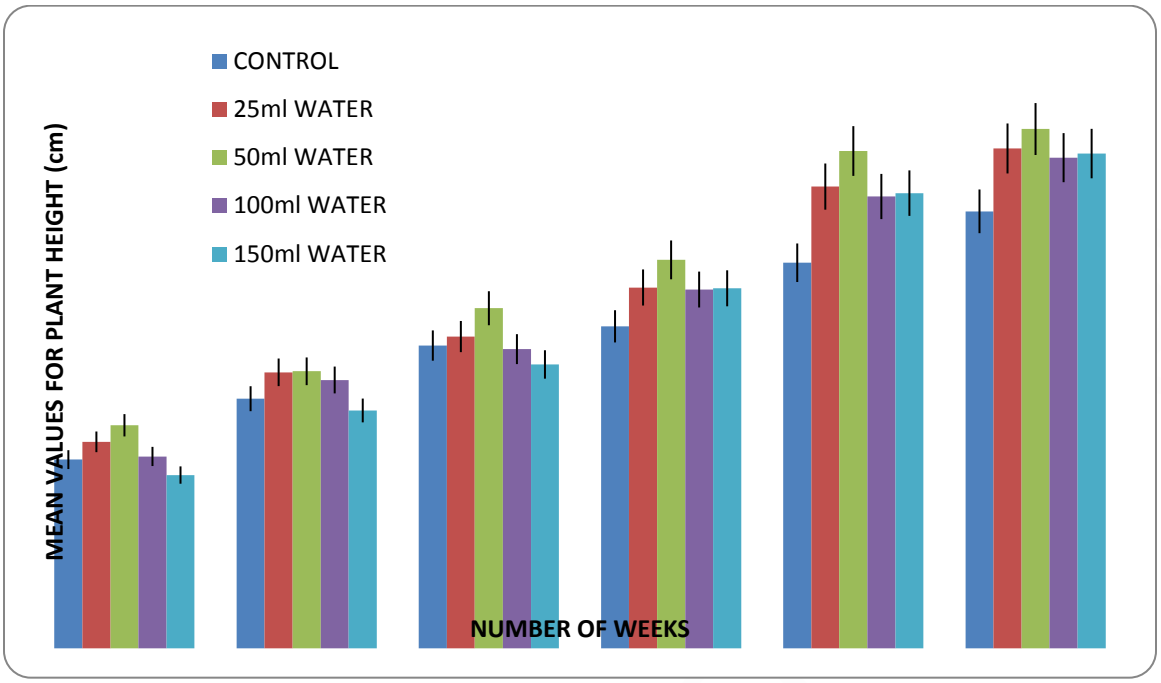

Figure 1 Effect of different concentrations of water on plant height of *Vigna unguiculata*

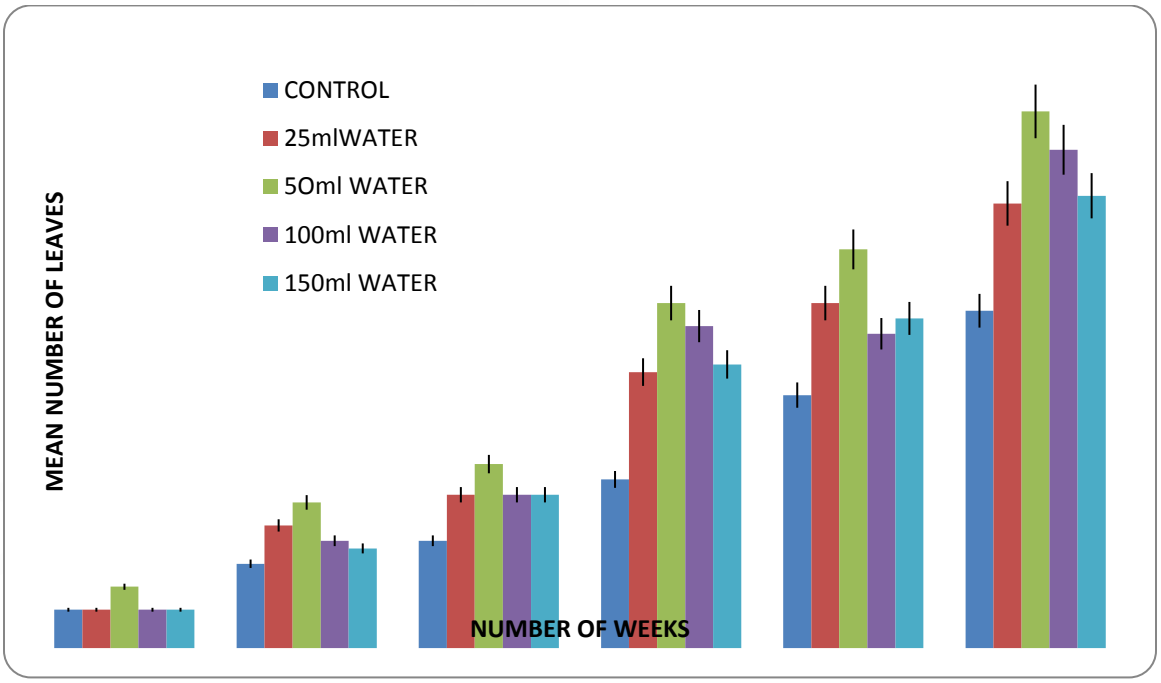

Figure 2 Effect of different concentrations of water on number of leaves of *Vigna unguiculata*

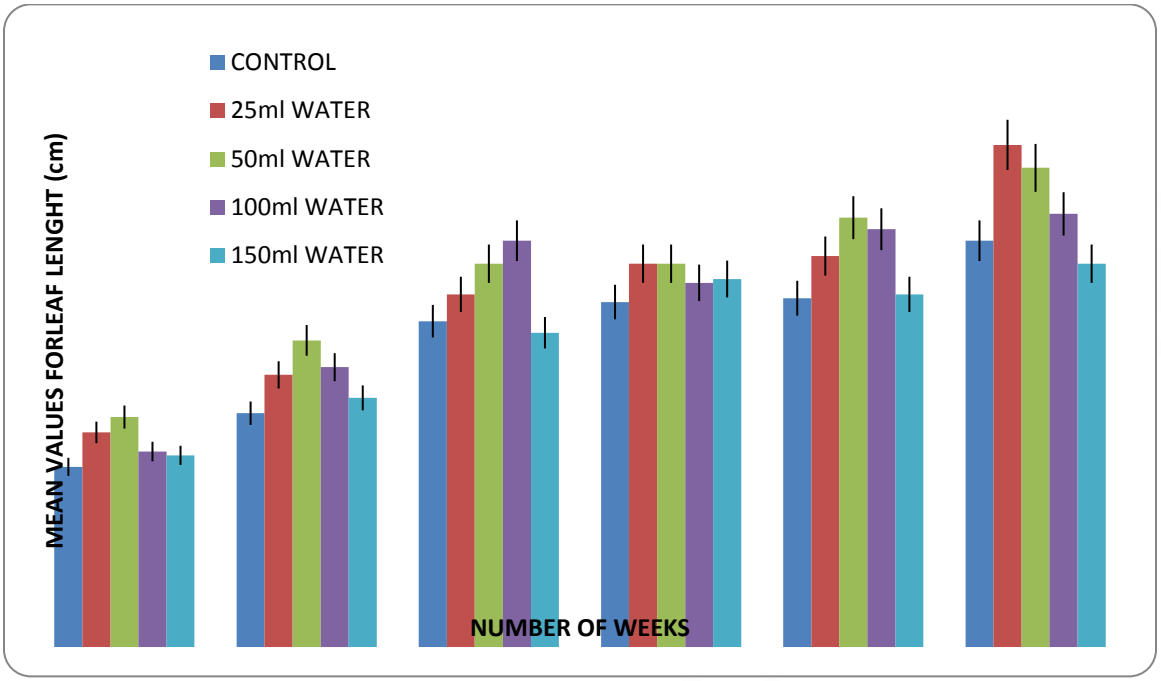

Figure 3 Effect of different concentrations of water on leaf length of *Vigna unguiculata*

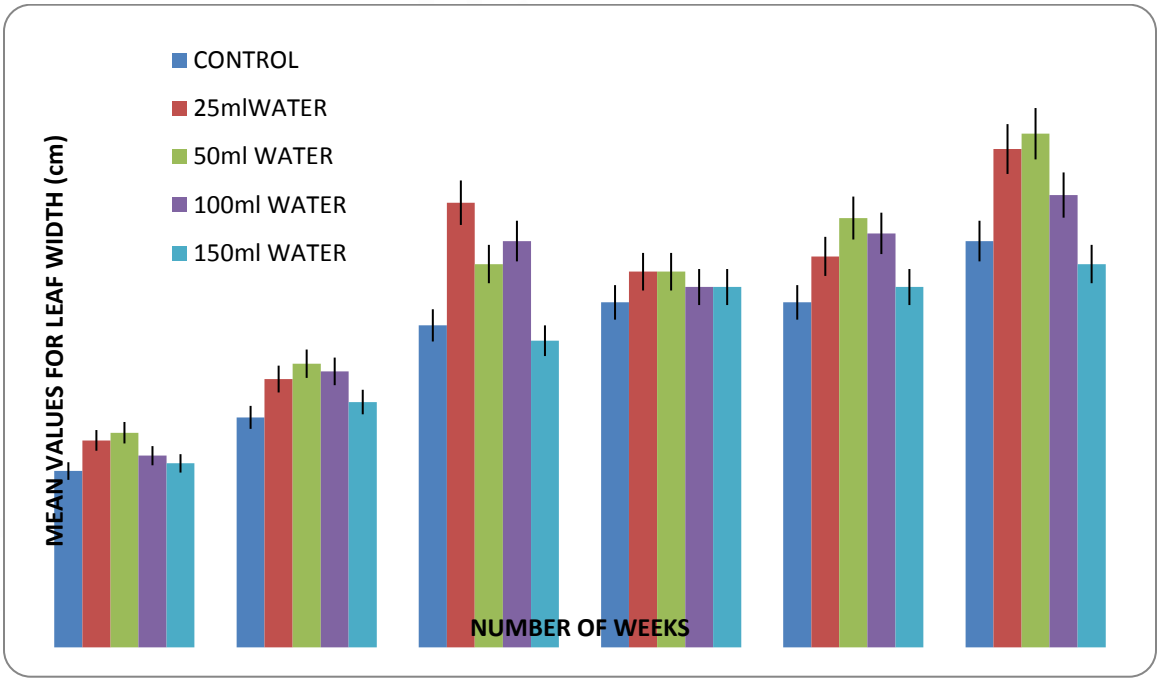

Figure 4 Effect of different concentrations of water on leaf width of *Vigna unguiculata*

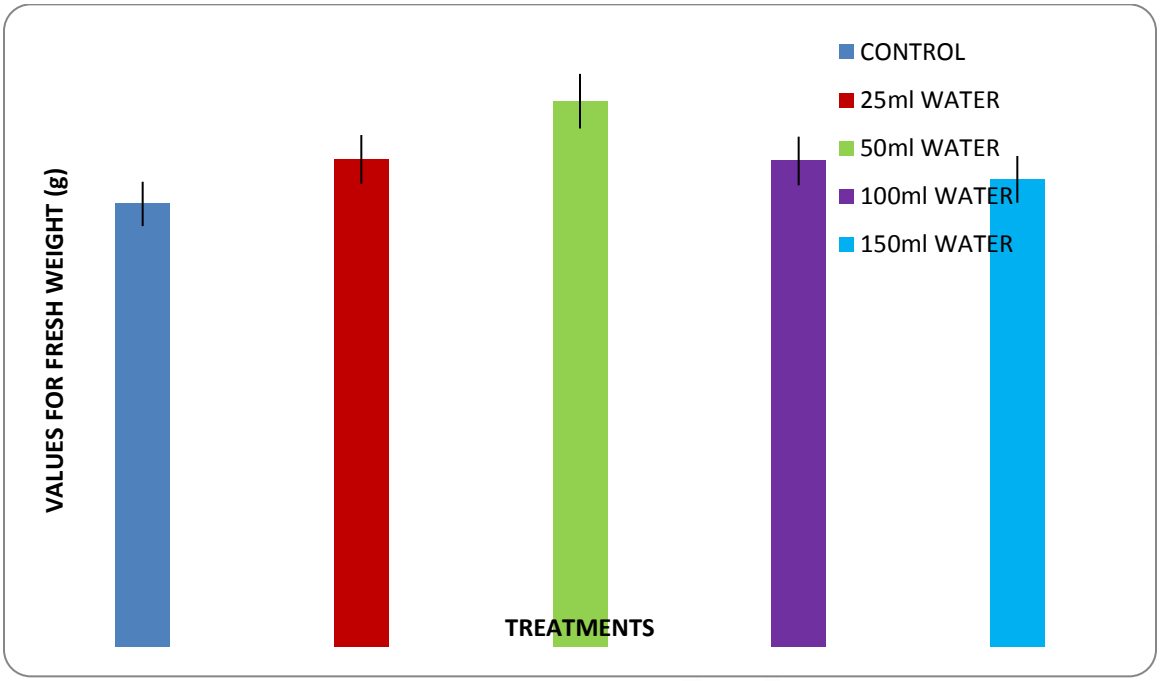

Figure 5 Effect of different concentrations of water on fresh weight of *Vigna unguiculata*

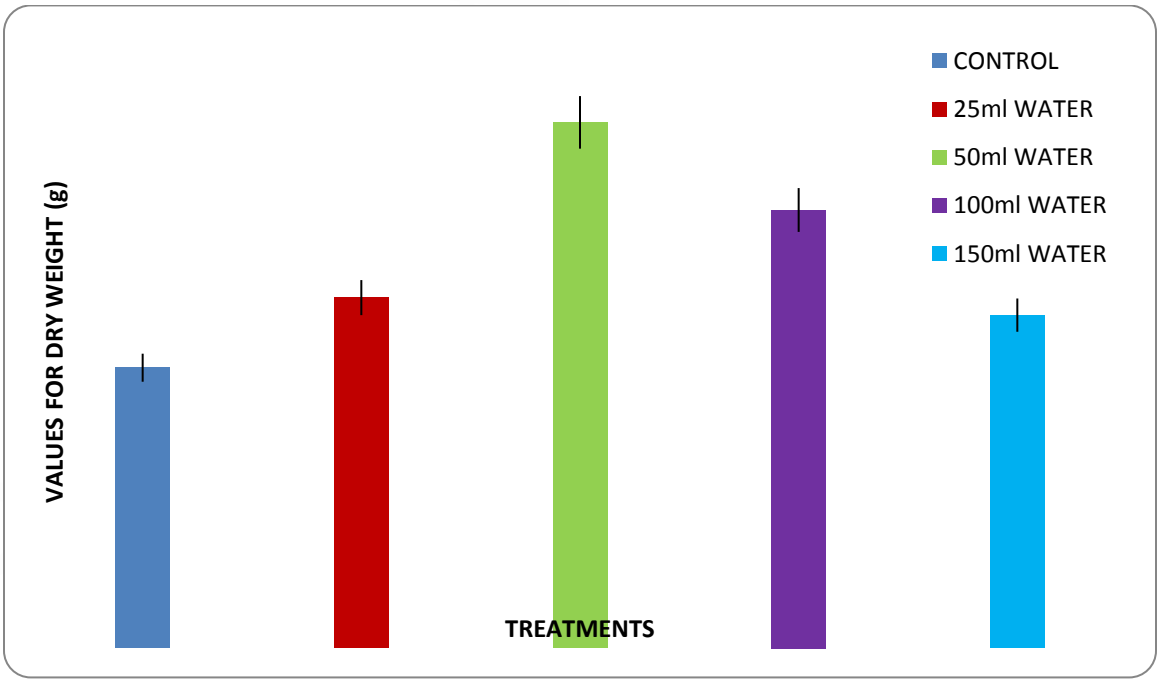

Figure 6 Effect of different concentrations of water on dry weight of *Vigna unguiculata*

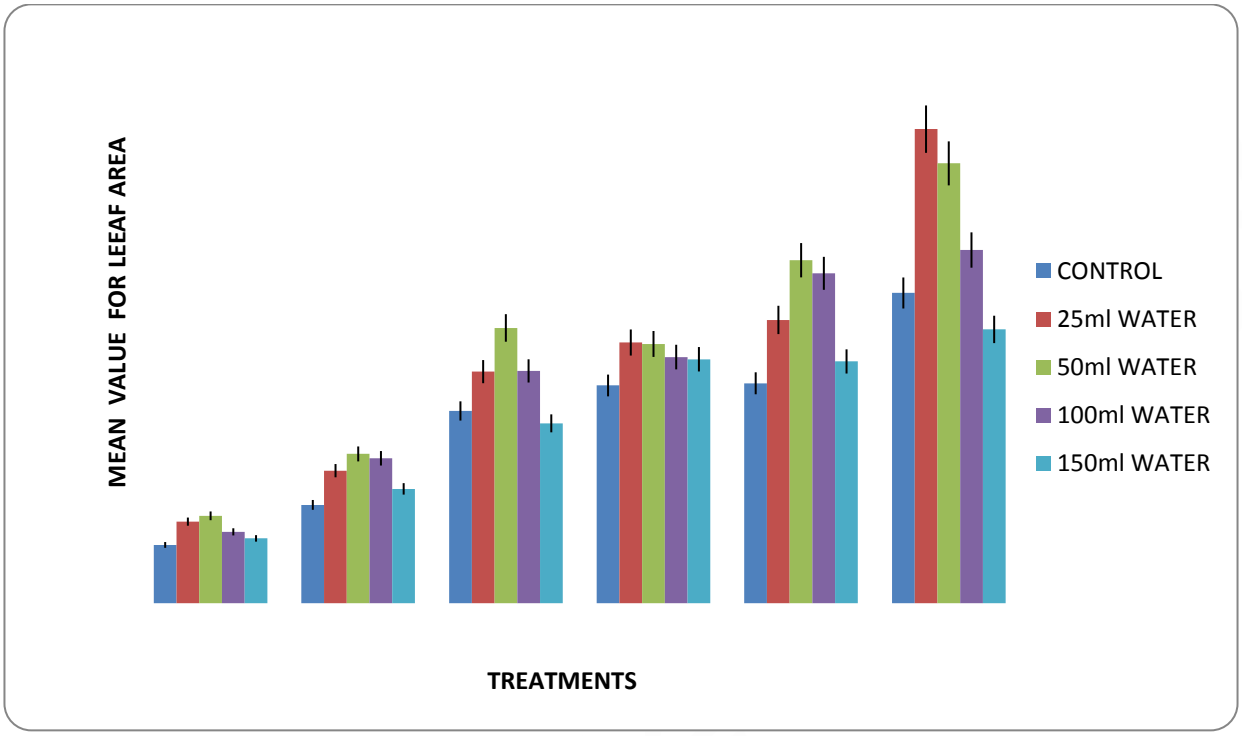

Figure 7 Effect of different concentrations of water on leaf area of *Vigna unguiculata*

Nutrients and antinutritive substances

Table 2 Proximate composition of the leaf of *Vigna unguiculata*

TEST PARAMETERS	RESULTS (%)
Moisture content	37.84±0. 133
Ash	8.74± 0.021
Fibre	5.88±0.014
Protein	17.50±0.008
Lipid	4.89±0.002
Carbohydrate	62.99±0.115
Caloric Value Kcal	365.97±1.305

Mean ±SD of 3 Determinations

The result shows that the Leaf of *Vigna unguiculata* has moisture content of37.84±0.133%, protein 17.50±0.008%, Ash 8.74± 0.021%, Fibre5.88±0.014%, Lipid 4.89±0.002%, Carbohydrate 62.99±0.115% and caloric value of 365.97±1.305% (Table 2)

Table 3 Mineral element contents of *Vigna unguiculata* leaf

MINERAL	SAMPLE COMPOSITION (MG/100G)
Magnesium (Mg)	12.63
Iron (Fe)	18.15
Potassium (K)	208.52
Sodium (Na)	126.14
Calcium (Ca)	236.11

The result of the mineral element determination of *Vigna unguiculata* leaf shows that Magnesium (Mg) content was 12.63 mg/100g, Iron (Fe) 18.5 mg/100g, potassium (K) 208.52mg/100, Sodium (Na) 126.14 mg/100g and Calcium (Ca) 236.11 mg/100g (Table 3).

Table 4 Anti-nutrents composition of *Vigna unguiculata* leaf

ANTINUTRIENT	SAMPLE COMPOSITION (mg/100g)
HCN	9.30±0.003
Phytate	29.40±0.033
Oxalate	255.20±0.712
Tannin	23.48±0.004

Mean ±SD of 3 Determinations

Table 4 shows the Anti-nutrient composition of V. *unguiculata*. The result shows that HCN was 9.30±0.003mg/100g, Phytate29.40±0.033mg/100g, Oxalate 255.20±0.712mg/100g and Tannin with 23.48±0.004mg/100g.

Table 5 Vitamin composition of *Vigna unguiculata* leaf

VITAMIN	SAMPLE COMPOSITION (mg/100g)
Vitamin A (Retinol)	6.36±0.005
Vitamin C (Ascorbic Acid)	34.05±0.003

The result of the vitamin composition of *V. unguiculata* shows that Vitamin A (Retinol) was 6.36±0.005mg/100g and Vitamin C (Ascorbic acid) also with 34.05±0.003mg/100g (Table 5).

4. DISCUSSION

Water gets into plants by flowing 'along a gradient of water potential existing between the soil solution and the air surrounding the plants'. 'This flow is likened to an electrical current whereby the rate of flow is dependent on the magnitude of the potential gradient and on the resistance offered by the water pathway' (Sutcliffe, 1999). When the potential gradient is large and the resistance is low, water flow is rapid, but when the potential gradient is small and the resistance is high, water flow is slow (Sutcliffe, 1999). The state of water in a soil or water content of a soil explains better why the leaves of plants growing in it becomes wilted and remain so until additional water is added. This condition is what Sutcliffe called the permanent wilting percentage PWP (Sutcliffe, 1999).

In this studies, the application of 50ml of water significantly ($p<0.05$) enhanced the growth performances of *Vigna unguiculata*. Excess water within the plant caused reduction in growth performances of the plant. Edmond *et al*., (1978) explained that under conditions that favour high absorption and low transpiration rates, there is a buildup of high turgor pressure in the region of cell elongation which causes maximum swelling of the cells.

The carbohydrate content was high (62.99±0.115%) suggesting that the leaf can serve as food. Themonosaccharide or disaccharide composition of the carbohydrate may be responsible for the after-sweet-taste of the leaf. The protein content was also high (17.50±0.008%) and readily available as a macronutrient. Protein is an essential component of human diet needed for the replacement of tissues and for the supply of energy and adequate amount of required amino acids. Protein deficiency causes growth retardation, muscle wasting, oedema, abnormal swelling of the belly and collection of fluids in the body of children (Mounts, 2000).The crude fibre content (5.88±0.014%) was high and may aid digestion, absorption of water from the body and bulk stool. Fibre softens stool and therefore, prevents constipation (Ayoola & Adeyeye, 2009). The vegetable may therefore be very useful in the control of body weight, blood cholesterol and protection against colon cancer. The lipid content (4.89±0.002%) of the vegetable was low, and it can therefore be recommended as part of weight reducing diets. Low lipid foods are said to reduce the level of cholesterol and obesity (Gordon & Kessel, 2002).

Of the minerals analyzed in the plant, calcium was the most abundant (236.11mg/100g) element, when compared with many reports that potassium is the most abundant mineral in Nigerian agricultural products (Afolabi *et al*., 1995). Potassium helps to maintain body weight and regulate water and electrolytebalance in the blood and tissues (National Research Council [NRC], 1989. The iron content of the vegetable was given as 18.15mg/100g, and compares favorably with other vegetables. Iron is said to be an important element in the diet of pregnant women, nursing mothers, infants, convalescing patients and the elderly to prevent anaemia and other related diseases (Oluyemi *et al*., 2006). The magnesium content of the leaf was found to be 12.63 mg/100 g. Magnesium plays fundamental roles in most reactions involving phosphate transfer. It is believed to be essential in the structural

stability of nucleic acids. It plays a significant role in the intestinal absorption of electrolyte in the body. Its deficiency in man includes severe diarrhea and persistent migraines (Appel, 1999).

Anti-nutritive factors limit the use of many plants for food because they elicit deleterious effects in both man and animals (Kubmarawa *et al*., 2008). Fortunately, the levels of anti-nutrients in this plant were found to be high compared to other vegetables in Nigeria (Agbaire *et al*., 2012). Oxalate content (255.20±0.712mg/100 g) found in this study was high and is below the established toxic level. Oxalate tends to render calcium unavailable by binding to plasma calcium ion to form complexes (Al-Rais *et al*., 1971; Ladeji, 2004, Nkafamiya *et al*., 2006).

The insoluble calcium oxalate complex may precipitate around soft tissues like the kidney, causing kidney stones (Oke, 1969). The phytate value recorded was low (29.40±0.033mg /100 g) and non-toxic. According to Oke (1969) a phytate diet of 1-6% over a long period of time decreases the bioavailability of mineral elements in mono gastric animals. Phytic acid is a strong chelator, forming protein and mineral-phytic acid complexes thereby decreasing protein and mineral bioavailability (Fasusi *et al*., 2003; Erdman, 1979). Phytate is associated with nutritional diseases such as rickets in children and osteomalacia in adult humans respectively. The cyanate level in the vegetable sample was also found to be high (9.30±0.003mg/100 g) and non-toxic to humans and animals. It has been established that excess cyanate in the body inhibits the cytochrome oxidase. This may stop ATP formation and the release of inorganic phosphate to body tissues. Consequently, the body suffers energy deprivation and subsequent death. High level of HCN has been implicated in cerebral damage and lethargy in man and animal.

5. CONCLUSION

The results from this study showed that the application of 50ml of water twice daily can enhanced the growth performances of *Vigna unguiculata*. The leaf have nutritional potential because it contains a high concentration of energy, nutrients, minerals, vitaminsand asa balanced and rich source of macro- and micronutrients. The leaf can be seen as a potential source of useful items for food formulation. The presence of harmful elements such as oxalate appears to be within permissible limits. Further research work is recommended to confirm some of the ethno-pharmacological claims on *Vigna unguiculata* and we also suggest that quality assurance and monitoring of toxic metals are needed for plants intended for human consumption.

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