

\*Original research paper

# GROWTH AND FOLIAR YIELD RESPONSES OF WATERLEAF (*Talinum triangulare* JACQ) TO COMPLEMENTARY APPLICATION OF ORGANIC AND INORGANIC FERTILIZERS ON AN ULTISOLS

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## ABSTRACT

Growth and foliar yield responses of waterleaf (*Talinum triangulare* Jacq) to complementary application of organic and inorganic fertilizers on an ultisols was studied at the University of Uyo Teaching and Research Farm, Use Offot in 2009 and 2010. The experiment was laid out in a randomized complete block design with three replicates. Treatments were six fertilizer rates: 400 kgha<sup>-1</sup> of NPK (15:15:15), 5 tha<sup>-1</sup> of poultry manure (PM), 200 kgha<sup>-1</sup> NPK+ 2.5 tha<sup>-1</sup> of PM , 100 kgha<sup>-1</sup> NPK + 3.75 tha<sup>-1</sup> of PM, 300 kgha<sup>-1</sup> NPK + 1.25 tha<sup>-1</sup> of PM and control. Results indicated significant differences (P<0.05) among the fertilizer treatments in waterleaf height, number of branches<sup>-1</sup>, number of leaves<sup>-1</sup>, stem girth, leaf area, and total foliage yield of waterleaf in both years. Generally, application of PM alone and complementary use of PM and NPK, irrespective of the ratio, enhanced waterleaf growth and total foliage yield better compared to application of NPK alone and the control treatment . Total foliage yield from 100 kgha<sup>-1</sup> NPK + 3.75 tha<sup>-1</sup> of PM treatment (56 .03 tha<sup>-1</sup> and 54 36 tha<sup>-1</sup> in 2009 and 2010, respectively) superseded other treatments by 37.66 - 78.35% in 2009 and 34.13 -76.96%. This study has strongly demonstrated the beneficial effects of using organic manure for waterleaf production.

**Keywords:** waterleaf, fertilizers, growth, foliar yield, ultisols

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43 **Introduction**

44 Waterleaf (*Talinum triangulare* Jacq), a vegetable crop that originates from tropical  
 45 Africa (Tindall,1983), is an all season vegetable that is extensively grown in many countries  
 46 in Asia, South America and west Africa. In Nigeria, it is widely cultivated and consumed in  
 47 the southern part, particularly in Cross River and Akwa Ibom States (Idiong *et. al.*, 2002;  
 48 Udoh *et. al.*, 2005). Waterleaf is therefore a major component of farming system and  
 49 promising vegetable due to its high demand and as a major source of income for farmers  
 50 particularly in Cross River and Akwa Ibom States. Its high demand is attributed to its  
 51 nutritional value and importance as a “softener” when cooking the common fibrous leafy  
 52 vegetables (Eyo *et. al.*, 2001) such as Afang (*Gnetum africana*), Atama (*Heinsia crinata*),  
 53 and Editan (*Lasienthera bulchozianum*). It is also cooked with green amaranthus  
 54 (*Amaranthus curentus*) and fluted pumpkin (*Telfairia occidentalis*). Its colloidal property is  
 55 superb, evident in the use for preparation of popular Efik/Ibibio soups known as *Ukwoho*  
 56 *afang* and *edikang ikong*. Ibeawuchi *et. al.* (2007) stated that the leaves and young shoots are  
 57 used to thicken sauce and is consumed in large quantities in the southern part of Nigeria. It is  
 58 considered medicinal in southern Nigeria as it is used as herb for measles and stomach upsets  
 59 (Udoh *et al.*,2005 ) while it performs well as fodder for raising giant snails (Ebenso and  
 60 Okafor, 2002). The increasing demand for waterleaf due to urbanization has pushed farmers  
 61 into small and medium scale production of waterleaf in Akwa Ibom State. Most farmers  
 62 apply assorted types of fertilizers (organic and inorganic) but sometimes the yield fail to  
 63 compensate the money spent on fertilizer. This is partly because most farmers are yet to  
 64 determine the best local fertilizer source to use in the vegetable crop production.

65 The use of animal and plant wastes in crop production is in deed a long standing  
 66 practice in the world. The use of inorganic fertilizers among farmers to improve waterleaf

yield is also common although some farmers and consumers still hold their faith against the use of inorganic fertilizer in leaf vegetable production. Most farmers broadcast large quantity of inorganic fertilizer in waterleaf plots at intervals of 2 to 30 weeks to stimulate growth. This is always aimed at achieving a higher yield (Steward *et. al.*, 2005) and maximum value of growth (Daudal *et. al.*, 2008). The inorganic fertilizer is considered a major source of plant nutrients (Naeem *et. al.*, 2006) for improving soil structure (Daudal *et. al.*, 2008) and microbial biomass (Sureh *et. al.*, 2004). However, the use of inorganic fertilizers alone may have negative implications for human health and the environment (Arisha and Bardisi, 1999). Therefore, the utilization of organic manures by vegetable producers may increase crop yields and ensured environmental harmony compared to chemical fertilizers. In developed nations, consumers are demanding higher quality and safer food and thus interested in produce obtained via organic farming. This is perhaps why Udoh *et. al.* (2005) recommended application of organic manures like cow dung, poultry droppings and nitrogenous fertilizers immediately after harvest. Farmers find it difficult to maintain a standard fertilizer regime in the cultivation of water leaf but often supplements organic manure with mineral fertilizers.

However information on the interaction effects between organic manure and mineral fertilizer application for waterleaf is scanty. The combined application of organic manure and mineral fertilizer is said to have additional advantage offering the soil against undesirable acidifications and a increased availability of micronutrients (Gill and Meelu, 1982). The blending of organic manures with mineral fertilizer will therefore help to increase the productivity crops on fragile soil by reducing the problem of nutrient losses via leaching or denitrification. Olsen *et. al.* (1986) found that a substantial portion of nitrogen fertilizer needs of most cereals could be met by organic manure blended with mineral fertilizer. The use of both mineral and organic fertilizers has been found to be a sustainable technology for crop production, and integration could further increase crop yield (Ndaeyo *et. al.*, 2005).

Application of organic and inorganic fertilizers can lead to significant improvement in shoot and fruit yield as well as shoot and seed quality of vegetables. Improved vegetable crop growth and yield performances with complementary application of inorganic and organic fertilizers compared to sole application of either organic or inorganic fertilizer have been reported (Kang and Balasubramanian, 1990; Ndaeyo *et al.*, 2005; Bayu *et al.*, 2006;; Ndaeyo *et al.*, 2007) The complementary use of organic manure and inorganic fertilizers have been proven to be a sound soil fertility management and crop production strategy in many countries of the world (Lombin *et al.*, 1991; Agboola *et al.*, 1998). High and sustained crop growth and yield could therefore be obtained with judicious, balanced and combine use of inorganic and organic fertilizers. This study was therefore conducted to evaluate the performances of different organic manure supplemented with a nitrogen fertilizer on growth and foliar yield of waterleaf in Uyo, Nigeria.

## Materials and Methods

The experiment was conducted at the University of Uyo Teaching and Research Farm, Use-Offot, Uyo, Akwa Ibom State of Nigeria in 2009 and 2010 early cropping seasons. The site is located at Latitude  $5^{\circ}17'N$  and  $5^{\circ}27'N$ , Longitude  $7^{\circ}27'E$  and  $7^{\circ}58'E$  and on altitude of 38.1m above sea level. This rainforest zone receives about 2500 mm rainfall annually. The rainfall pattern is bimodal, with long (March - July) and short (September – November) rainy seasons separated by a short dry spell of uncertain length usually during the month of August. The mean relative humidity is 78% and the atmospheric temperature is  $30^{\circ}C$ . The mean sunshine hours is 12 (Peters *et al.*, 1989). Soil analysis revealed the following physico-chemical characteristics: pH in water value of 5.6, 1.37 % organic matter, 0.10 % total nitrogen, 31.77 mg/kg available P, 199.02% K and, exchangeable Ca and Mg of 2.88 and 1.20 mg/kg, respectively. The soil particle analyses were: sand 86.89 %, silt 2.81% and clay 10.31%.

The experiment was laid out in a randomized complete block design with three replicates. Treatments were six fertilizer rates: 400 kg ha<sup>-1</sup> of NPK (15:15:15), 5 t ha<sup>-1</sup> of poultry manure (PM), 2.5 t ha<sup>-1</sup> + 200 kg ha<sup>-1</sup> NPK of PM, 100 kg ha<sup>-1</sup> NPK + 3.75 t ha<sup>-1</sup> of PM, 300 kg ha<sup>-1</sup> NPK + 1.25 t ha<sup>-1</sup> of PM and control. Each plot measured 6m x 6m with 1m inter-plot and replicate spacing. The site was cleared manually and organic manures incorporated into the soil during preparation of raised seed bed while NPK (15:15:15) fertilizer was applied two weeks after planting according to treatment. Planting was done manually at a spacing of 5cm x 5cm using stem cuttings of 10 cm with leaves still attached. Manual weeding was carried out at 3, 6 and 9, weeks after planting. The following growth and yield parameters: height, number of leaves per plant, leaf area (determined graphically in cm<sup>2</sup>), number of branches per plant, stem girth (cm) and total fresh foliage yield (t/ha) were determined. Data collected were subjected to analysis of variance and means compared using least significant difference (P<0.05).

## Results

### Plant height and number of branches

Table 1 shows that at 3, 6, 9 and 12 WAP, there were significant differences (P<0.05) in the height of waterleaf among the different fertilizer treatments in 2009. The 100 kg/ha of NPK + 3.75 t/ha PM treatment produced the tallest waterleaf plants at all sampling periods while the control consistently produced the shortest waterleaf. Application of poultry manure treatment alone enhanced plant height better than the 400 kg/ha treatment. In 2010, waterleaf height also differed significantly (p<0.05) at all sampling months among the fertilizer treatments (Table 2). At 3, 6, 9 and 12 WAP, combined application of 100 kg/ha of NPK + 3.75 t/ha PM produced the tallest plant while the control had the shortest plants. Plants from 100 kg/ha of NPK + 3.75 t/ha PM treated plots were taller than those of other treatments by

12-60% by the 12<sup>th</sup> WAP (Table 2). The use of poultry manure alone was better than that of 400kg NPK (15:15:15).

Table 3 shows that at 3, 6, 9 and 12 WAP, there were significant differences in the number of branches per plant ( $P<0.05$ ) among the different fertilizer treatments in 2009. The 100 kg/ha of NPK + 3.75 t/ha PM had the highest number of branches per plant while the control had the least number of branches per plant. The number of branches per plant also differed significantly ( $P<0.05$ ) in 2010 among the fertilizer treatments (Table 4). The control treatment consistently produced the least number of branches per plant at all sampling periods while 100 kg/ha of NPK + 3.75 t/ha PM treatment consistently produced the highest number of branches per plant at all sampling periods. The 100 kg/ha of NPK + 3.75 t/ha PM treatment had 18-62% more number of branches per plant than other treatments. Application of poultry manure alone produced more branches than the NPK 400kg/ha treatment.

#### Number of leaves and stem girth

At 3, 6, 9 and 12 WAP, the number of leaves per plant differed significantly ( $P\leq 0.05$ ) among the different fertilizer treatments in 2009 (Table 5). The 100 kg/ha of NPK + 3.75 t/ha PM treatment had the highest number of leaves per plant while the control had the least number of leaves per plant. Application of poultry manure alone produced more leaves than NPK 400kg/ha. The number of leaves per plant also differed significantly ( $P<0.05$ ) among the fertilizer treatments in 2010 (Table 6). The control treatment consistently produced the least number of leaves per plant while the 100 kg/ha of NPK + 3.75 t/ha PM consistently produced the highest number of leaves per plant at all sampling periods. The 100 kg/ha of NPK + 3.75 t/ha PM had 16-54% more leaves than other treatments by the 12<sup>th</sup> WAP. Application of poultry manure alone produced more leaves than application of NPK at 400kg/ha.

In 2009, stem girth at 3, 6, 9 and 12 WAP differed significantly (Table 7) among the different fertilizer treatments. The 100 kg/ha of NPK + 3.75 t/ha PM produced the biggest stem girth. The smallest stem girth was produced by the control treatment. Stem girth in 5 t/ha poultry manure treatment was bigger than that of NPK 400 kg/ha. Waterleaf stem girth differed significantly ( $P<0.05$ ) among fertilizer treatment in 2010 (Table 8). The application of 100 kg/ha of NPK + 3.75 t/ha PM resulted in the production waterleaf with bigger stem girth while the control had the smallest stem girth. The application of poultry manure only had bigger stem girth than 400kg/ha of NPK (15:15:15) treatment.

#### **Leaf area and total foliage yield**

Table 9 shows that at 3, 6, 9 and 12 WAP, the leaf area of waterleaf differed significantly ( $P<0.05$ ) among the different fertilizer treatments in 2009. The 100 kg/ha of NPK + 3.75 t/ha PM produced the largest leaf area while the control treatment produced the smallest leaf area.

Waterleaf leaf area was significantly ( $P<0.05$ ) influenced by the fertilizer treatments in 2010 (Table 10). The 100 kg/ha of NPK + 3.75 t/ha PM treatment produced the widest leaves while the control treatment had the smallest leaf size. Generally, the 5t/ha PM treatment produced bigger leaves than sole application of 400kg/ha NPK (15:15:15) fertilizer. Table 11 shows that, the total fresh foliage yield of waterleaf differed significantly ( $P<0.05$ ) among the different fertilizer treatments in 2009. The 100 kg/ha of NPK + 3.75 t/ha PM treatment had the highest total foliage yield (56.03t/ha) while the control had the least total foliage yield (12.12 t/ha). The 100 kg/ha of NPK + 3.75 t/ha PM treatment produced 37 – 78% more foliage than other treatments. Total fresh foliage yield of waterleaf differed significantly ( $P<0.05$ ) among the fertilizer treatments in 2010 (Table 11). The control treatment had the least total fresh foliage yield (9.86t/ha) while 100 kg/ha of NPK + 3.75 t/ha PM had the highest (54.13t/ha). Total fresh foliage yield from 100 kg/ha of NPK + 3.75 t/ha

PM treatment superseded others by 34 – 78%. Foliage yield from the sole application of 5t/ha PM was higher than that of 400kg/ha NPK by 15% and 13% in 2009 and 2010 ,respectively.

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## 196 Discussion

197 Results of **this** showed significant differences on all the vegetative characteristics and  
 198 foliage yield. The study has also demonstrated that application of 5 tha<sup>-1</sup> of poultry manure  
 199 alone performed better than the 400kg/ha treatment. However, combined application of 100  
 200 kgha<sup>-1</sup> NPK + 3.75 tha<sup>-1</sup> of PM resulted in increase in vegetative growth and foliage yield of  
 201 waterleaf than other treatments. This may be due to synergistic effects of combining organic  
 202 and inorganic fertilizers which optimally supplied needed plant nutrients. The mineral  
 203 fertilizer supplied the needed nutrients to the waterleaf at the initial growth stage while the  
 204 poultry manure provided the needed nutrients at later growth stages. Udoh *et al.* (2005) and  
 205 Ndaeyo *et. al.*, (2007) stated that the use of organic manure can enhance soil productivity and  
 206 crop yield. **This also confirms the findings of Alves *et. al.* (1993) that nutrients which are**  
 207 **most limiting in most tropical soils are nitrogen and phosphorus but because of the**  
 208 **immobility of phosphorus in the soil, it is well conserved in the plant/soil systems.** Alves *et.*  
 209 *al.* (1993) stressed the need to supplement organic manures with nitrogen fertilizers so as to  
 210 increase nitrogen supply and in addition contribute to the increase in organic matter of the  
 211 soil and other macro and micro nutrients required for crop growth. **The primary purpose of**  
 212 **using nitrogen fertilizer on crop is to increase the yield of dry matter .This is apparently why**  
 213 **100 kgha<sup>-1</sup> NPK + 3.75 tha<sup>-1</sup> of PM performed better than other treatments.** These findings  
 214 **also agree with that of Gill and Meelu (1982) that** crop yield increased with **increased** in the  
 215 level of nitrogen blended manure. **Also combined application of organic manure and mineral**  
 216 **fertilizer, particular in the tropics, had additional advantages of buffering the soil against**  
 217 **undesirable acidification and also increase the availability of micro nutrients.** The variability  
 218 in the performance of the fertilizer treatments could be due to variation in their nutrient

composition since different ratios were combined (Aliyu, 2000). Aliyu (2000) and Dauda *et al.* (2008) also reported that application of poultry manure at 5tha<sup>-1</sup> and farm yard manure at 5-10tha<sup>-1</sup> supplemented with 50kgNha<sup>-1</sup> resulted in adequate crop growth and maximum fruit yield of pepper and water melon, respectively. Findings from this study are in consonance with that of Abgede (2010) who reported that combined application of sub-optimal rates of N:P:K fertilizer and poultry manure enhanced plant performance compared with application of NPK fertilizer or poultry manure alone. The slight differences observed in vegetative growth of waterleaf in both cropping seasons could be attributed to vagaries of weather.

## Conclusion

With the high cost, scarcity and environmental problems associated with use of mineral fertilizer in Nigeria, the use of organic manure with or without supplementing with mineral fertilizer could be a better alternative for waterleaf production. It is also obvious that it would partly solve the problem of disposing various kinds of organic waste in our environment.

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334 **Table 1: Waterleaf height (cm) as influenced by fertilizer application in 2009**

| Treatment                             | Weeks | after | planting |       |
|---------------------------------------|-------|-------|----------|-------|
|                                       | 3     | 6     | 9        | 12    |
| 400kg/ha                              | 8.32  | 9.63  | 9.30     | 8.60  |
| 5t/ha poultry manure (PM)             | 8.78  | 10.70 | 10.90    | 9.83  |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 13.27 | 15.30 | 14.40    | 13.67 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 11.83 | 13.70 | 13.17    | 12.40 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 15.10 | 16.83 | 16.60    | 15.47 |
| Control (no fertilizer Application)   | 7.00  | 7.80  | 7.40     | 6.83  |
| LSD (P<0.05 )                         | 0.54  | 0.39  | 0.45     | 0.54  |



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339 **Table 2: Waterleaf height (cm) as influenced by fertilizer application in 2010**

| Treatment                             | Weeks | after | plantig |       |
|---------------------------------------|-------|-------|---------|-------|
|                                       | 3     | 6     | 9       | 12    |
| 400kg/ha                              | 8.21  | 9.46  | 9.34    | 8.65  |
| 5t/ha poultry manure (PM)             | 8.74  | 10.66 | 10.74   | 9.78  |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 13.18 | 15.26 | 14.12   | 13.56 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 11.74 | 13.72 | 13.19   | 12.46 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 15.12 | 16.80 | 16.62   | 15.43 |
| Control (no fertilizer Application)   | 7.03  | 7.75  | 7.35    | 6.79  |
| LSD (P<0.05 )                         | 0.56  | 0.36  | 0.48    | 0.51  |

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343 **Table 3: Number of branches per pant of waterleaf as influenced by fertilizer**  
344 **application in 2009**

| Treatment                             | Weeks | After | planting |       |
|---------------------------------------|-------|-------|----------|-------|
|                                       | 3     | 6     | 9        | 12    |
| 400kg/ha                              | 5.66  | 7.22  | 6.00     | 5.11  |
| 5t/ha poultry manure (PM)             | 6.45  | 7.19  | 21.33    | 6.44  |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 8.03  | 8.67  | 8.55     | 7.67  |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 7.55  | 8.44  | 12.78    | 19.34 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 10.78 | 10.78 | 16.11    | 9.33  |
| Control (no fertilizer Application)   | 4.78  | 5.78  | 5.33     | 4.22  |
| LSD (P<0.05 )                         | 1.29  | 1.55  | 1.74     | 1.17  |

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**Table 4: Number of branches per pant of waterleaf as influenced by fertilizer application in 2010**

| Treatment                             | Weeks | After | planting |      |
|---------------------------------------|-------|-------|----------|------|
|                                       | 3     | 6     | 9        | 12   |
| 400kg/ha                              | 4.98  | 7.16  | 6.07     | 5.09 |
| 5t/ha poultry manure (PM)             | 6.33  | 7.17  | 7.35     | 6.47 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 8.05  | 8.65  | 8.57     | 7.66 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 7.56  | 8.41  | 8.83     | 6.19 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 9.81  | 9.76  | 9.21     | 9.30 |
| Control (no fertilizer Application)   | 4.11  | 5.62  | 5.54     | 4.18 |
| LSD (P<0.05 )                         | 1.32  | 1.46  | 1.39     | 1.72 |

**Table 5: Number of leaves per plant of waterleaf as influenced by fertilizer application in 2009**

| Treatment                             | Weeks | after | planting |       |
|---------------------------------------|-------|-------|----------|-------|
|                                       | 3     | 6     | 9        | 12    |
| 400kg/ha                              | 10.22 | 12.89 | 13.44    | 13.34 |
| 5t/ha poultry manure (PM)             | 14.12 | 39.14 | 26.18    | 24.18 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 15.67 | 18.56 | 18.66    | 15.89 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 14.32 | 18.56 | 20.56    | 20.89 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 13.56 | 20.33 | 23.44    | 24.33 |
| Control (no fertilizer Application)   | 8.33  | 9.67  | 10.44    | 10.89 |
| LSD (P<0.05 )                         | 1.39  | 1.52  | 2.68     | 3.07  |

**Table 6: Number of leaves per plant of waterleaf as influenced by fertilizer application in 2010**

| Treatment                             | Weeks | after | planting |       |
|---------------------------------------|-------|-------|----------|-------|
|                                       | 3     | 6     | 9        | 12    |
| 400kg/ha                              | 10.13 | 12.09 | 13.12    | 13.36 |
| 5t/ha poultry manure (PM)             | 12.41 | 14.11 | 18.02    | 18.30 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 15.47 | 18.54 | 19.03    | 15.36 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 14.36 | 18.54 | 20.03    | 20.19 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 14.11 | 20.89 | 23.18    | 24.12 |
| Control (no fertilizer Application)   | 7.98  | 8.66  | 9.99     | 11.02 |
| LSD (P<0.05 )                         | 1.33  | 1.54  | 2.59     | 3.03  |

**Table 7: Waterleaf stem girth as influenced by fertilizer application in 2009**

| Treatment                             | Weeks | after | planting |      |
|---------------------------------------|-------|-------|----------|------|
|                                       | 3     | 6     | 9        | 12   |
| 400kg/ha                              | 1.10  | 2.37  | 2.51     | 2.37 |
| 5t/ha poultry manure (PM)             | 1.27  | 2.30  | 2.43     | 2.53 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 2.10  | 2.70  | 2.80     | 2.90 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 1.77  | 2.53  | 2.50     | 2.70 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 2.40  | 2.90  | 3.00     | 3.10 |
| Control (no fertilizer Application)   | 1.07  | 2.10  | 2.13     | 2.59 |
| LSD (P<0.05 )                         | 0.32  | 0.15  | 0.19     | 0.84 |

**Table 8: Waterleaf stem girth as influenced by fertilizer application in 2010**

| Treatment                             | Weeks | after | planting |      |
|---------------------------------------|-------|-------|----------|------|
|                                       | 3     | 6     | 9        | 12   |
| 400kg/ha                              | 1.12  | 2.38  | 2.48     | 2.32 |
| 5t/ha poultry manure (PM)             | 1.25  | 2.31  | 2.47     | 2.51 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 2.12  | 2.75  | 2.85     | 2.94 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 1.79  | 2.51  | 2.47     | 2.80 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 2.37  | 2.92  | 3.06     | 3.07 |
| Control (no fertilizer Application)   | 1.04  | 2.06  | 2.00     | 2.11 |
| LSD (P<0.05 )                         | 0.29  | 0.17  | 0.16     | 0.86 |

**Table 9: Waterleaf leaf area (cm<sup>2</sup>) as influenced by fertilizer application in 2009**

| Treatment                             | Weeks | after | planting |       |
|---------------------------------------|-------|-------|----------|-------|
|                                       | 3     | 6     | 9        | 12    |
| 400 kg/ha NPK (15:15:15)              | 7.97  | 10.70 | 8.84     | 8.31  |
| 5 t/ha Poultry Manure (PM)            | 8.19  | 11.66 | 10.01    | 8.99  |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 10.63 | 14.48 | 12.99    | 11.28 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 9.80  | 13.31 | 11.09    | 10.07 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 12.08 | 15.83 | 13.72    | 12.70 |
| Control (no fertilizer application)   | 6.67  | 10.56 | 8.36     | 7.28  |
| LSD (P<0.05)                          | 0.59  | 0.30  | 0.49     | 0.56  |

**Table 10: Waterleaf leaf area (cm<sup>2</sup>) as influenced by fertilizer application in 2010**

| Treatment                             | Weeks | After planting |       |       |
|---------------------------------------|-------|----------------|-------|-------|
|                                       | 3     | 6              | 9     | 12    |
| 400 kg/ha NPK (15:15:15)              | 8.01  | 10.72          | 8.80  | 8.36  |
| 5 t/ha Poultry Manure (PM)            | 8.12  | 11.86          | 10.21 | 9.06  |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 11.12 | 15.03          | 13.01 | 11.57 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 9.82  | 13.34          | 11.12 | 10.04 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 12.11 | 15.67          | 13.69 | 12.68 |
| Control (No fertilizer application)   | 6.62  | 10.11          | 8.32  | 7.30  |
| LSD (P<0.05)                          | 0.62  | 0.41           | 1.26  | 1.13  |

**Table 11: Total fresh foliage yield (t/ha) of waterleaf as influenced fertilizer application**

| Treatment                             | 2009  | 2010  |
|---------------------------------------|-------|-------|
| 400 kg/ha NPK (15:15:15)              | 19.73 | 20.06 |
| 5 t/ha Poultry Manure (PM)            | 23.33 | 22.96 |
| 200kg/ha NPK (15:15:15) + 2.5t/ha PM  | 34.93 | 35.13 |
| 300kg/ha NPK (15:15:15) + 1.25t/ha PM | 28.40 | 27.99 |
| 100kg/ha NPK (15:15:15) + 3.75t/ha PM | 56.03 | 54.36 |
| Control (no fertilizer application)   | 12.13 | 11.71 |
| LSD (P<0.05)                          | 10.23 | 9.86  |