International Journal of Scientific World, 5 (2) (2017) 126-130

International Journal of Scientific World

Website: www.sciencepubco.com/index.php/IJSW
doi: 10.14419/ijsw.v5i2.8112
Research paper

Responses of Utasi (*Gongronema latifolium*) to NPK 15:15:15 Fertilizer Rates in a Utisol South-South Nigeria

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Abstract

Gongronema latifolium (Benth) called Utasi by Igbos and Arokeke by Yorubas belongs to Ascepiadaceae family. It is an herbaceous climbing plant found in the tropical region. The leaves are used for food, culinary, medicinal and other domestic purposes. The plant is found among the wild and is not cultivated in regular farms. It is one of the endanger species that stands the risk of been extinct. Therefore, the study was carried out to determine the responses of *Gongronema latifolium* to seven rates of NPK 15:15:15 fertilizer during 2014 and 2015 cropping seasons at the Teaching and Research Farm, Agronomy Department, Cross River University of Technology Obubra, Cross River State, Nigeria. The experimental design was a randomized complete block design. Treatments were seven rates; 0kg/ha, 50, 100, 150, 200, 250 and 300kg/ha of NPK (15:15:15) fertilizer replicated four times. Results showed that application of 300kg/ha of NPK 15:15:15 fertilizer gave a higher number of leaves, branches per plant and tallest plants than the other rates of NPK fertilizer. The highest leaf yields in hectares were obtained in plots treated with 200kg/ha in 2014 and 2015 seasons respectively.
Based on these findings, farmers are advice to domesticate and cultivate *Gongronema latifolium* with the application of 200kg/ha NPK 15:15:15 fertilizer for optimum growth and leaf yield.

Keywords: *NPK Fertilizer; Gongronema latifolium; Utasi; Fertilizer Impact; Fertilizer Rate.*

1. Introduction

Gongronema latifolium (Benth) belongs to the family Asclepiadaceae [1]. It is an herbaceous climbing leaf and a known indigenous plant that grows in the wild tropical rain forest of southern Nigeria.
It is called UtasI by the Igbos and Arokeke by Yoruba's tribes of Nigeria [2]. The leaves of *Gongronema latifolium* are rich in vitamins, minerals and phytochemicals and is used as vegetables spice for soup and meat preparations [3]. Extracts from the leaves, veins and roots are used for a medicinal purpose for the treatment of diabetes, stomach pains, and worm infestation [4]; [1].
Despite the economic importance of *Gongronema latifolium*, there is scanty literature information on the agronomic, cultural techniques, fertilizer requires for it domestication and cultivation in regular farms and at the commercial scale in Nigeria.
The crop is currently found in the wild forest where persons especially women and children usually search to harvest as the need arise. Attempt to domesticate the plant is ongoing by some peasants farmers and Researchers who have used either seeds or vine cuttings as propagating materials [5].
Literature shows that the application of mineral fertilizers significantly increased the growth and yield of crops, especially leafy vegetables. [6]; [7]; [8]; [9]. Documented information about the response of *Gongronema latifolium* to mineral fertilizer, especially NPK based fertilizers are lacking.
Therefore, this study is aimed to determine the rate of NPK 15:15:15 fertilizer that will be appropriate for optimum growth and yield of *Gongronema latifolium* in Obubra, South-South Nigeria.

2. Material and methods

Studies were carried out in the Cross River University of Technology, Department of Agronomy, Teaching and Research Farm, Faculty of Agriculture Obubra, Cross River State, South-South Nigeria during the 2014 and 2015 cropping seasons. The Geographical location of Obubra lies between latitude"$05^{0}59^{'}$ and longitude "$08^{0}18^{'}$"East [10].

2.1. Land preparation

Experimental field that measured 24x14metres with area of $336m^2$ (0.336 ha) was cleared, ploughed, harrowed and divided into three blocks. Each block was sub-divided into seven plots of 4x3m ($12m^2$) each in April 15^{th}, 2014 and 2015 cropping season respectively. Each plot was separated by 0.5m path from adjourning plot. Soil samples were collected at random from 50 different points using steel auger at depth of 0 cm – 20cm. The soil samples were bulked together, mixed thoroughly, from where a composite soil sample was collected for laboratory soil analysis, to determine physical and chemical properties of the site using standard laboratory procedures.

2.2. Planting of *Gongronema latifolium*

Gongronema latifolium was propagated vegetatively (by vine cuttings). Mature fresh vine cuttings were obtained from the wild rain forest of Ovonum- Obubra and Ikom local Government Areas Councils, Cross River State, as there is yet no source of improved planting materials. Each vine cuttings measured 30cm-35cm long with about 4-5 nodes (buds) were used as planting materials.
Plantings of the vine cuttings were done on 25th April, 2014 and 2015 at a spacing of 70x50cm inter and intra row at the depth of 2-3cm with 2-3 nodes covered inside the soil and the other 2-3 nodes outside the soil.

2.3. Experimental Design

The experimental design was a Randomized Complete Block Design. Treatments were seven rates of NPK 15:15:15 fertilizer at 0, 50, 100, 150, 200; 250 and 300kg/ha replicated four times. The fertilizer was applied at four weeks after planting by side binding method.

2.4. Cultural Practices

- *Staking of seedlings*

Gongronema seedlings were stake using bamboo stake at four weeks after planting (WAP).

- *Weed control*

Weeding was alone manually using hoe on a regular basis to keep the experimental field weed free as possible.

- *Harvesting*

The leaves of *Gongronema latifolium* were harvested as green vegetables when needed. The harvesting began at eight weeks after planting and continues at every 3-4-week interval.
During harvesting, only fresh green young succulent leaves were cut using a kitchen knife.

2.5. Data collection

Data were collected on the following parameters:

- Number of leaves, branches per plant, plant height (cm)
- Leaf area index: Days to 1st& 50% flowering & fruiting, dry matter plant fraction.
- Crop growth rate (CGR).
- Fresh leaf yield per plant & per hectare.
- Dry matter yield per plant & hectare
- Leaf area index. (LAI);

Leaf Area Index was determined using;
$LAI=La \times (p)^{-1}$
Where
LAI=Leaf area index
La= Total leaf area per plant
P= feeding area available (for ground support). This supports the view of Radford and Brown [11]
Crop growth rate: (C G R).
Where
CGR= crop growth rate
$CGR= W_2 - W_1$ g/m2/day
SA $(t_2 - t_1)$
Were: CGR= Crop growth rate.
W_1 and W_2 = dry weight at beginning and end of the interval of growth period
t_1 and t_2= sampling time 1 and 2
SA= the area occupied by the plant at sampling

2.6. Statistical analysis

Data collected were statistically analyzed using analysis of variance (ANOVA) procedure for randomize complete block design experiments [12]. Separation of treatments means for significant difference was done using Fishers Least Significant Difference (FLSD) at 0.05 probability level as described by Obi [13].

3. Result and Discussion

3.1. Weather condition of the study site

Summary of the weather data presented on Table 1 shows that the mean annual rainfall, temperature, relative humidity (April – December) were (23214mm, 30.2^{0}C and 81.2% in 2014) and (229.7mm, 30.5^{0}C and 79.1% in 2015) cropping seasons respectively and were appropriate for the growth *of Gongronema latifolium* plant.

Table 1: Summary of Weather Data of Thee Experimental Sites in 2014 and 2015 Cropping Seasons

Months	Rainfall (mm)	Temperature (°C) Maximum	Minimum	Relative Humidity (%)
2014 Cropping Season				
April	141.3	34.2	26.2	80.3
May	231.1	32.1	25.1	83.7
June	351.3	30.1	24.3	85.4
July	494.2	28.3	21.5	87.3
August	201.5	30.1	25.1	82.9
September	311.2	27.4	27.3	84.1
October	232.7	29.7	24.2	81.7
November	100.3	31.8	20.3	78.3
December	27.1	28.5	19.7	67.5
Total	2091.7	272.2	213.7	731.2
Mean	232.41	30.24	23.74	81.24
2015 Cropping Seasons				
April	163.2	33.5	25.8	81.1
May	263.1	31.3	22.1	83.1
June	537.1	30.1	23.1	87.7
July	637.5	32.3	24.3	90.8
August	389.8	29.2	25.1	85.3
September	421.5	28.1	31.4	87.2
October	301.2	30.4	20.3	75.5
November	187.1	29.5	20.1	84.1
December	15.3	29.5	20.1	65.7
Total	2915.8	273.9	212.3	740.5
Mean	323.98	30.43	23.59	82.28

Source: Cross River University of Technology, Obubra Meteorological station.

The soil analysis results in Table 2 indicated that the soil is slightly acidic with pH of 5.04 in water and 4.90 in KCl and 5.0 in water and 4.91 in KCl in 2014 and 2015 seasons respectively. Soil macro organic matter including macro-nutrients (Nitrogen, Phosphorus and Potassium) were low.
Agba [14] and Adiaha [15] work in similar locations had recommended the application of mineral fertilizer to such soils with low nutrients status to increase the growth and yield of crops.

Table 2: Physical and Chemical Properties of the Soil of the Experimental Sites in 2014 and 2015 Cropping Season

Soil Properties	Values 2014	2015
Mechanical Properties		
Coarse sand (%)	13.4	14.1
Fine Sand (%)	65.1	66.5
Silt (%)	18.2	19.3
Clay (%)	5.2	6.4
Textural class	Sandy loam	Sandy loam
Chemical properties		
pH in water	5.04	5.06
pH in kcl	4.90	4.91
Organic carbon (%)	0.82	0.83
Organic matter (%)	1.26	1.32
Nitrogen (%)	0.07	0,09
Available phosphorus (cmol/kg)	3.67	3.89
Base Saturation (%)	1,518	1,471
Exchangeable cation (cmol/kg)		
Potassium	0.23	0.34
Magnesuim	1.83	1.77
Calcuim	3.41	3.29
Sodium	0.15	0.18
Aluminum	0.11	0.12
Hydrogen	0.62	0.68
Cation exchange capacity (Cmol/kg)	85.3	82.1

3.2. Numbers of Leaves and Branches per Plant

The application of NPK 15:15:15 fertilizer significantly (P = 0.05) increased the numbers of leaves and branches per plant in all the periods of measurements at 6, 12 and 18 weeks after planting (WAP) as shown in table 3. Number of leaves increased with successive increment in the rates of NPK 15:15:15 fertilizer and the age of the plant. The highest number of leaves per plant 112.4 in 2014 and 114.2 in 2015 were recorded in plots that NPK fertilizer were treated with 300kg/ha at 18 weeks after planting (WAP).

On the other hand, fertilizer application has no significant effects on number of branches per plant at the early period of 6 WAP. However, the effect of NPK fertilizer on number of branches became significant at 12 and 18 WAP and followed similar trend as that recorded on number of leaves per plants.

The analyzed data on plant height showed increased in plant height as *Gongronema latifolium* age increase from 6 – 18 WAP. However, taller plants with longer vine length were observed in NPK 15:15:15 fertilizer plots than those plots not treated with fertilizer (control plots).

The significant increase in the vegetative growth parameters (number of leaves, branches, per plant and plant height measured as vine length) in this experiment agrees with the findings of Agba and Enya [16]; Adiaha and Agba [17], who reported significant increase in cucumber and maize (*Zea mays* L.) growth parameters when NPK fertilizer was applied in cultivating them.

Table 3: Effects of NPK 15:15:15 Fertilizer on the Growth Number of Leaves Branches Per Plant and Plant Height (Cm) of *Gongronema latifolium* in 2014 and 2015 Cropping Season

NPK 15:15:15 fertilizer rate (kg/ha)	No. of leaves per plant			No. of Branches per plant			Plant Height (cm)			Mean	LSD (0.05)
	6 WAP	12 WAP	18 WAP	6 WAP	12 WAP	18 WAP	6 WAP	12 WAP	18 WAP		
2014 Cropping Season											
0	11..3	23.1	42.4	2.4	4.1	5.3	25.3	51.4	94.2	28.82	3.1
50	18.2	38.2	61.3	3.2	7.3	9.2	30.5	73.5	143.1	42.71	3.4
100	22.3	43.3	69.2	3.3	8.1	11.3	33.6	81.3	165.3	48.62	4.2
150	24.2	51.1	82.3	3.1	9.2	11.4	35.7	90.6	201.2	56.53	4.5
200	27.2	62.3	90.2	3.3	9.3	12.3	40.1	104.3	233.7	59.34	5.1
250	29.1	81.4	103.2	3.1	10.2	14.1	44.3	121.7	256.8	73.78	6.2
300	30.3	94.2	112.4	4.0	10.1	14.3	49.7	152.3	304.5	85.76	7.2
Mean	23.2	56.2	93.5		8.32	11.1	39.03	96.4	199.8		
LSD(0.05)	1.3	3.0	5.1	N.S	1.01	1.01	2.1	3.3			
2015 Cropping Season											
0	10.2	21.3	39.3	1.4	3.4	4.4	21.8	49.6	101.5	28.11	2.2
50	19.1	36.3	55.2	3.1	6.3	8.2	32.3	68.9	137.3	40.74	3.4
100	21.3	41.2	74.1	3.2	7.4	10.3	37.1	80.2	157.2	46.86	4.2
150	23.2	53.1	81.4	3.3	8.4	10.2	41.3	89.8	212.5	58.13	4.6
200	26.1	60.4	93.1	3.2	9.3	11.1	48.8	112.5	241.4	67.32	5.2
250	28.2	83.1	101.3	4.11	11.1	12.3	53.1	131.4	253.6	75.3	6.7
300	31.4	96.3	114.2	4.0	8.2	14.2	57.2	158.4	311.71	83.51	7.3
Mean	22.9	55.96	79.8	3.28	0.11	10.1	41.6	98.4	202.1		
LSD(0.05)	1.5	3.5	4.6	NS	1.01	1.2	2.3	3.2			

Table 4: Effects of NPK 15:15:15 Fertilizer on the Dry Matter (G/Plant) Leaf and Vine Weight of *Grongronema latifoliumin* in 2014 and 2015 Cropping Season

NPK 15:15:15 fertilizer rate (kg/ha)	Leaf dry weight per plant			Vine dry weight per plant(g)			Mean	LSD (0.05)
	6 WAP	12 WAP	18 WAP	6 WAP	12 WAP	18 WAP		
2014 Cropping Season								
0	33.31	57.14	81.57	19.78	30.42	78.85	50.35	
50	42.27	73.52	147.52	26.11	47.31	154.35	81.81	
100	50.35	87.33	175.15	33.27	65.27	181.42	98.80	
150	61.42	94.15	192.26	45.15	139.16	196.16	121.40	
200	74.56	113.26	215.44	50.30	190.35	221.37	144.21	
250	82.18	141.11	253.12	69.22	112.17	270.42	154.70	
300	66.24	97.53	183.33	48.33	96.72	191.10	113.88	
Mean	58.62	94.86	178.3	41.94	87.34	157.62		
LSD(0.05)	5.12	6.31	10.12	3.02	7.51	17.21		
2015 Cropping Season								
0	37.15	60.23	90.11	23.15	41.32	54.74	51.12	
50	40.32	82.14	127.50	35.34	58.14	75.33	69.80	
100	52.97	89.85	181.41	39.79	70.22	91.45	87.12	
150	64.28	95.43	209.55	42.34	77.15	105.31	99.18	
200	81.13	109.87	127.16	53.12	83.12	129.25	110.80	
250	89.13	150.03	251.31	63.24	107.58	231.16	148.82	
300	70.07	95.33	177.38	50.32	79.95	107.31	96.73	
Mean	61.07	97.55	166.35	43.76	73.93	113.51		
LSD(0.05)	4.92	6.53	11.25	3.51	7.73			

Table 4 Shows the effects of NPK 15:15:15 fertilizer on dry matter of *Gongronema latifolium*.

Results of analysis of variance (ANOVA) indicates significant high leaf and vine dry matter weight per plant in NPK fertilizer treated plots than the non-fertilized plots.

At 6, 12 and 18 WAP, leaf and vine dry matter weight per plant increase with increase in NPK 15:15:15 fertilizer rates. However, the increase in dry matter weight was up to 250kg/ha rate of NPK fertilizer beyond which both leaf and vine dry matter weight per plant began to decrease as the rate of NPK fertilizer increase.

The application of 300kg/ha of NPK 15:15:15 fertilizer produced lower leaf and vine dry matter weight as compared to the lower rate of 200kg/ha. The highest (P = 0.05) leaf dry weight (253.12 per plant in 2004 and 251.31g/plant in 2015) and vine (112.17g/plant in 2014 and 231.16g/plant) received 250kg/ha of NPK 15:15:15 fertilizer.

These significantly high leaf and vine dry weights per plant recorded in NPK 15:15:15 fertilizer treated plots especially with 250kg/ha showed higher dry weight per plant than the other fertilizer rates, this corroborates with the work of Agba and Enya [16]; Ainika, and Amens[18] that reported similar effects of fertilizer on the growth of *Amarathus* vegetable leaf and growth rates.

3.3. Leaf and Vine

The analyzed result on *Gongronema latifolium* leaf and vine growth rate measured as dry mater accumulation in plants parts at regular period of 5.28 days interval is summarized in table 5.

The result revealed that leaf and vine growth rate was low at the early period of 30 – 58 and 58 – 86 days after planting (DAP).
However, between (86 – 114) DAP and (114 – 142 DAP), leaf and vine growth rate double with plots treated with NPK 15:15:15 fertilizer recording higher leaf and vine growth rate than the plots not treated with NPK fertilizer.
Maximum leaf and vine growth rates of leaf (5.0383g/m^2/day in 2015) and vine (4.4367g/m^2/day in 2014 and 4.537g/m^2/day in 2015 were observed between the period of 86 – 114 DAP in the two cropping seasons (2014 and 2015) respectively. Agba et al.[6] obtained similar leaf and vine growth rates in *Mucuna flagellipes* plants treated with Urea fertilizer.

Table 5: Effect of NPK 15"15:15 Fertilizer on Fresh Leaf Yield of Utasi *Gongronema latifolium* in 2014 and 2015 Cropping Season

NPK 15"15:15 fertilizer rate (kg/ha)	Leaf yield per plant (g)						Leaf yield per hectare (t /ha)						Means	LSD ().05)
	6 WAP	8 WAP	12 WAP	16 WAP	20 WAP	24 WAP	6 WAP	8 WAP	12 WAP	16 WAP	20 WAP	24 WAP		
2014 Cropping Season														
0	54.3	71.1	83.4	94.3	111.5	72.3	0.12	0.31	0.42	0.51	0.59	0.63	40.7	0.10
50	83.2	98.6	114.7	124.8	153.1	94.6	0.45	0.72	1.03	1.44	1.75	0.54	56.2	0.11
100	107.4	130.7	153.5	175.2	201.3	112.3	0.61	0.91	1.34	1.68	1.83	0.73	80.9	2.3
150	121.5	162.1	181.6	197.3	245.8	124.1	0.82	1.03	1.57	1.93	2.14	1.08	87.3	3.5
200	153.7	179.2	193.4	232.5	261.4	132.3	0.94	1.21	1.86	2.05	2.31	1.24	86.84	4.1
250	162.9	191.5	211.7	251.4	285.2	151.6	0.99	1.43	1.93	2.41	2.14	1.53	105.41	5.2
300	110.2	142.3	162.3	183.2	194.8	101.5	0.53	0.51	0.82	1.02	1.41	0.86	74.44	
Mean	113.3	139.3	157.2	179.8	207.6	112.7	0.64	0.87	1.28	1.58	1.84	0.89		
LSD(0.05)	20.2	15.4	16.1	17.5	19.4	18.5	0.01	0.01	0.01	0.01	0.01	0.01		
2015 Cropping Season														
0	52.6	73.2	80.2	91.7	116.3	67.4	0.14	0.30	0.41	0.53	0.62	0.12	41.30	0.12
50	80.5	96.3	109.5	126.1	149.4	95.3	0.47	0.69	1.04	1.06	1.72	0.52	55.30	0.13
100	111.3	141.1	150.6	171.5	198.7	104.5	0.63	0.90	1.32	1.65	1.91	0.73	23.74	2.2
150	124.2	160.8	179.8	190.7	239.8	122.7	0.81	1.04	1.55	1.94	2.16	1.08	56.58	3.4
200	147.3	181.3	190.5	231.6	260.7	133.0	0.95	1.23	1.88	2.07	2.37	1.26	98.18	4.3
250	165.4	190.8	209.6	148.3	283.1	153.3	0.98	1.45	1.95	2.43	2.68	1.58	105.13	5.1
300	106.3	140.3	157.2	181.3	192.3	102.4	0.52	0.51	0.82	1.04	1.46	0.87	73.79	
Mean	112.66	141.10	153.9	177.4	205.8	111.2	0.64	0.87	1.28	1.52	1.85	0.80		
LSD(0.05)	21.1	16.1	15.4	17.8	19.3	18.7	0.01	0.01	0.01	0.01	0.01	0.01		

Table 5 also shows the result of the summary of the analysis of variance of Leaf Area Index (LAI of *Gongronema latifolium* as influenced by NPK 15:15:15 fertilizer at 6, 12 and 18 WAP. Leaf area index increased gradually at 6 – 12 WAP with NPK fertilizer recorded higher leaf area index value than the non-fertilizer plants. At 12 WAP, the application of 150 – 200kg/ha did not show any significant different on the LAI.
However at 18 WAP, LAE increase with incremental rate of NPK fertilizer, the highest value of LAI (4.134 in 2014 and 4.151 in 2015) was obtained at 300kg/ha of NPK fertilizer rate. This finding agrees with the research outcome of Asiegbu and Agba [19] reporting high LAI values as result of NPK fertilizer application on *Mmucuna flagellipes*.
The result also shows that the application of NKP fertilizer significantly promoted earlier flowering and fruiting of *Congronema latifoluim* as compared to plants that were not applies with fertilizer. Throughout the periods of duration of the studies (2014 – 2015) all cases where 250 kg/ha of fertilizer were applied significantly (P = 0.05) flower and fruit earlier than plots that received either lower or higher rates of NPK fertilizer. Similarly, Agba [20] observed earlier flowering in *Mucuna flagellipes* in response to NPK fertilizer application.
Table 5 further showed the analysis of variance result of the effects of NKP fertilizer on fresh leaf yield of *Gongronema latifolium*. The application of NKP fertilizer significantly (P = 0.05) increased the fresh leaf yield of the plant/fresh leaf yield per plant and per hectare were higher in plots treated with 250kg/ha as compare to other plots that were treated with lower or higher rates of NPK fertilizer in both 2014 and 2015 cropping seasons. This result is in line with the findings of Aninika and Amans [18] that obtained increased fresh leaf yield due to NPK fertilizer application in *Amaranthus species*.

4. Conclusion

The result of the study showed that the application of different rates of NPK 15:15:15 fertilizer significantly increased the growth and yield of *Gongronema latifolium*. The used of 300 kg/ha gave highest vegetative growth such as number of leaves, branches, and LAI. While 250 kg/ha promoted earlier flowering, fruiting, dry mater weight of leaf, vine crop growth rate and fresh leaf yield per plant and hectare. Farmers are advice to apply 250 kg/ha NPK 15: 15:15 fertilizer for optimum growth and yield of *Congrone malatifolium.*

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