GROWTH AND YIELD RESPONSE OF UTASI (Gongronema latifolium(Benth)*) TO POULTRY MANURE AND PLANTING DISTANCE IN TROPICAL ULTISOL*

ABSTRACT

Gongronema latifolium(Benth) commonly call ‘ Utasi”, or “Arokeke” in local Nigerian languages (Igbo and yoruba) names belongs to the family *Asclepiadaceae* is a neglected vegetable in Nigeria. The plant has high economic importance, the leaves, stem and roots are very useful for food, medicine and other domestic purposes. Studies were conducted to determine effects of poultry manure and planting distance on the growth and yield of utasi (*Gongronema latifolium)* in a tropical utisol of the Cross River University of Technology, Department of Agronomy ,Faculty of Agriculture, Obubra, Cross River state, Nigeria in 2017 and 2018 cropping seasons. The experimental design was a 4 x 5 factorial laid out in a randomized complete block design. Treatments were 4 planting distances of 100 X 40, 100 X 60, 100 X 80 and 100 X 100cm and five rates of poultry manure at 0,1.0, 2.5, 3.5, and 4.5. They were 20 treatments combination replicated three times. Data collected on growth and yield parameters were statistically analyzed using analysis of variance (ANOVA)procedure. Results showed *that* wider intra row planting distance gave higher number of leaves, branches and dry matter of plant fractions than closer row planting distance.The application of poultry manure significantly ($p<0.05$) increased plant height, the number of leaves and branches per plant . Poultry manure rate of 4.5 t/ha recorded the highest leaf area index , number of leaves per plant (36.2) and (38.4) at 50% anthesis in 2017 and 2018 cropping seasons respectively. The was significant interaction between poultry manure and planting distance.The highest *Gongronema latifolium* fresh leaves yield at 21 WAP (151.37g in 2017 and 153.42g in 2018) and dry leaf yield (60.55g in 2017, and 61.28g in 2018) yield per plant were obtained in wider intra row planting distance of 100 x 100cm that received 3.5t/ha, poultry manure at 21 weeks after planting , while the closer inter row planting distance of 100 x 40cm that received 3.5t/ha poultry manure produced the highest fresh leaves yield of (3.512t/ha in 2018 and 3.613 t/ha in 2019) and dry leaf yield of (0.788t/ha in 2017 and 0.986 t/ha in 2018) yield per hectare in both cropping seasons (2017 and 2018).Farmers are advice to cultivate Utasi (*Gongronema latifolium*) at panting distance of 100 x 40 cm with the application of 3.5t/ha poultry manure for optimum growth and yield in an utisolof tropical agro ecological zone.

Keywords: Growth, Yield Utasi (Gongronema latifolium)

1 .INTRODUCTION

Utasi (Gongronema latifolium(Benth)) belongs to the family Asclepiadaceae (Burkill,1985). The plant has high economic importance. Both the leaves, stem and roots are very useful for food, medicine and other domestic purposes. In Nigeria, the Igbos and Effiks call it Utasi, while the Yorubas call it Arokeket (Emeka, and Obiora 2009). The leaves are used as vegetables to prepare soup, stews and spice to garnish meat and sauce by most people of South east and South-South, Nigeria. Studies showed that Utasi (*Gongronema latifolium)* leaves and stem contain high phytochemicals and extracts from the leaves, veins and roots are used for medicinal purpose for the treatment of diabetes, stomach pains, and worm infestation (Akah and Okafor ,1992Morebise, *et al;*2002)). Despite the high economic importance of Utasi (*Gongronema latifolium)* there are no literature on agronomic techniques of it cultivation in regular farms. It is one of the less known, under exploited indigenous herbaceous climbing plant found in the wild tropics of South-South, Nigeria. Currently, the plant is not cultivated in regular farms, few peasant farmers, traditional or herbal medicine men and researchers normally go to the wild forest to search and harvest Utasi (*Gongronema latifolium)* whenever it is needed. The plant is one of the endanger species that is becoming very difficult to get even in time of dear need. One of the factors that affect plant growth and yield is planting distance (inter and intra row spacing). This is because plant density which is determine by plant spacing has direct effects on plant competition for basic necessities of life (air, water, light, nutrients and space) (Blufistone and Kolin ,2011). Crops that are planted in plots with optimum spacing will have sufficient leaves canopyto cover ground surface as quickly as possible with leaf area index that will harvest enough solar radiation for optimum photosynthesis.

Optimum Crop production (yield) in Nigeria especially Cross River state is rapidly declining over the years due to poor soil fertility ,soil degradation and deficiency in

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Comment [SKS6]: What is the meaning of dear need?

Comment [SKS7]: Change as growth resources

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some soil minerals among other factors (Agbo*et al*,2006, Blufistone and Kolin ,2011, Agba,2016).

Comment [SKS10]: Join both paragraphs

Research has shown that leafy vegetables respond well to adequate supply of organic manure especially poultry manure. Poultry manure supplies the essential macro and micro nutrients elements to vegetable crops as well as improves soil physico chemical conditions for better vegetables crops growth and yield (Ogbonna and Obi, 2005).

Literature information is lacking on the use of organic manure especially poultry manure) or planting distance on the growth and yield of Utasi (*Gongronema latifolium)* . Therefore, this study was conducted to determine appropriate planting distance or poultry manure rate or combined rate of poultry manure and planting distance that are require for optimum growth and yield of Utasi (*Gongronema latifolium)* in a tropical utisol of South –South , Nigerian agro ecological zone.

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2. MATERIALS AND METHODS

2.1. Experimental Site and plot layout

Field studies were carried out during the 2017 and 2018 cropping seasons at the Teaching and Research farm, Agronomy Department, Cross River University of Technology, Faculty of Agriculture and Forestry, Obubra, Cross River State. The experimental area fall within the rain forest zone of South- South, Nigeria and is located between Latitude 05^{0} 59"N and Longitude 08^{0} 16" E with annual rainfall of 2250- 2500 mm (Cross River Agricultural Development Project (CRADP 1992)). The weather conditions during the growing seasons of this experiments in 2017 and 2018 is as shown in Table1

2.2 Land preparation

The site used for this experiment was left fallow for two years as at when it was cleared, ploughed and harrowed using manual labour on 28th March, 2017 and 2018. Before commencement ofUtasi*Gongronemalatifoluim* planting, random soil samples were collected from 40 locations with soil auger at a depth of 0- 25cm. The samples were bulked and mixed thoroughly from where a sub sample was collected for laboratory analysis to determine the physical and chemical properties of the site (Table 2).Samples were air-dried and sieved with 2 mm sieve. Routine soil analysis was done using standard laboratory methods as described by Tel (1984). Soil pH in 1:2 water and $CaCl_2$ suspension was determined using soil pH meter, total Nitrogen by Kjeldahlapproach and available Phosphorus by Bray-P extraction followed by molybdenum blue colorimeter, Exchangeable potassium, calcium, and magnesium were extracted using ammonium acetate, potassium was determined using flame photometer, calcium, and magnesium by EDTA titration. Soil organic matter was determined by wet dichromate method. Result of soil analysis showed that the soil is sandy loam, acidic, low in nitrogen, organic matter, potassium, phosphorus and magnesium (AOAC, 2000).

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Comment [SKS16]: Use the word method instead of approach

Poultry manure was analyzed using standard laboratory methods as described for soil analysisand the result shown in Table 3.

The field was divided into three blocks , each block had twenty (20) plots of 5 x 6m ($30m^2$)

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2.3 Poultry manure application

Dry well cured decomposed poultry manure collected from poultry pens in Obubra local Government Area, Cross River, State, Nigeria, was stored in sacks for one month before application. The method of application was by broadcast plough down. The require quantity (rate) of poultry manure according to the schedule treatments rates (0,1.0, 2.5,3.5, 4.5

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tons/ha) was broadcast on each plot thoroughly mixed with the soil and completely work into the soil using a garden fork . It was allowed for a period of 2 weeks before planting of*Utasi(Gongronema latifolium)*was done.

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2.4 Experimental Design

The experiment was a 4 x 5 factorial of four planting distance : 100 x 40, 100 x 60, 100 x 80 ,100 x 100 cm and five poultry manure rates: 0,1.0, 2.5,3.5, 4.5 tons/ha. Poultry manure was collected from commercial poultry farms in Obubra and well cured by being tied in sack bags for one month whose chemical composition is shown in Table 3. The well cured poultry manure was applied at two weeks before planting by broadcasting and completely worked into the soil .

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2.5 . Planting of Utasi (*Gongronemalatifolium*)

Utasi (*Gongronemalatifolium*) was planted using vegetative method of propagation through vines cuttings. The mature fresh vines cuttings were collected from Obubra forest and cut into pieces of 25-30cm long with 5-6 buds (nodes) per vine as there is yet no source for improved planting materials. They were planted on 10th April ,2017 and 2018 cropping seasons. Planting was done at the rate of one cutting per hole at the depth of 2-3cm with 2-3 nodes covered in the soil and 2-3 nodes out of the soil using the various plant distance listed above in the experimental treatments .

Table 1.Plant densities derived from each planting distance and feeding area per plant

Plant spacing	Number of plants/ha	Feeding area/plant
100 x 40 cm	25,000	4,000 cm
100 x 60 cm	16,666	6,000 cm
100 x 80 cm	12,500	8,000 cm
100 x 100 cm	10,000	10,000 cm

2.6 CULTURAL PRACTCES

Staking of seedlings: Utasi (*Gongronema latifolium)* plant has weak vines that climb on shrubs and trees for support . Therefore in this experiment , the seedlings were supported with bamboo stakes at three weeks after planting.

Weeding: Weed control was done manually using small weeding hoe to keep the plots weed free throughout the duration of the experiment in 2017 and 2018 seasons.

2.7. HARVESTING

Harvesting began at nine weeks after planting. Fresh young leaves of Utasi (*Gongronema latifolium)* were cut using kitchen knife and were weighed using electronic weighing balance to determine the weight per plant, plot and per hectare at 9WAP,15WAP and 21WAP in 2017 and 2018 respectively.

Comment [SKS22]: Mention as fresh weight

2.8. DATA COLLECTION : Utasi (*Gongronema latifolium)* growth and yield data were collected as : plant height (measured as main vine length (cm)), number of leaves, branches per plant, dry matter of leaf and (stem) vine, fresh and dry leaf yield per plant, plot and hectare, leaf area index at 6 weeks after planting (WAP) and 50% anthesis, crop growth rate ($g/m^2/day$) in 2018 and 2019 cropping seasons.

Crop Growth Rate Analysis: Analysis of leaf, stem and root growth rate were evaluated at three stages of 21 days after planting (DAP), 45DAP and 70 DA P for the two seasons through destructive sampling of one plant per plot using the growth analysis techniques described by Shortal and Liebbardt (2000) as shown below :

Crop Growth Rate (CGR)

CGR = $\underline{W_2 - W_1}$ $g/m^2/day$

$SA (t_2 – t_1)$

Where:

W_1 and W_2 = dry weight of nodule 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.

Leaf Area Index (LAI) was estimated from leaf area. Leaf area was measured using the leaves of the plants that were collected from the middle row in each plot for crop growth analysis.The leaveswere taken to the laboratory where the leaf area was measured using the Leaf area Meter (Model-MK-2) . From the measured leaf area, leaf area index was determined based on the relationship as stated below by Shortal and Liebbardt (2000).

$$LAI = Y \times N \times A_1 \times (A_P)^{-1}$$

Where:

LAI= Leaf Area Index

Y=population of plants per plot

N=Average number of leaves per plant

A_1=Average area per leaf

A_P=Area of plot``

2.7. STATISTICAL ANALYSIS

All data collected were analyzed statistically using Analysis of variance (ANOVA) Procedure described by Gomez and Gomez (1986). Fishers Least Significant Difference (LSD) at 50% probability level was used to separate experimental treatments that were significant (Obi, 2002).

3. RESULTS

Climatic data of the experimental site showed that the rainy season in the study area occurs between April and November with peak rainfall of 506.32mm and 613.2mm in the month of July in 2017 and 2018 cropping seasons respectively within the duration of the study (Table 2).The average relative humidity and temperature were high enough for crop growth throughout the two seasons. The soil of the study site has the texture of sandy loam, low in organic matter, nitrogen ,acidic with a Ph of 5.04 , 4.03 in water and KCl respectively. Poultry manure was low in nitrogen and organic matter content as compare with the Range reported by Dauda *et al* ; (2008) from analysis of poultry manure. The application of poultry manure significantly ($p<0.05$) increased the number of leaves per plant (Table 5). The number of leaves per plant increases with every successive increase in poultry manure rate, with 4.5 t/ha poultry manure recorded the highest number of leaves per plant (36.2) and (38.4) at 50% anthesis in 2017 and 2018 cropping seasons respectively. Poultry manure application significantly increased leaf area index development with higher leaf area index obtained in plots that had 4.5t/ha of poultry manure as compare with lower rate of poultry manure. Similarly the same poultry manure rate of 4.5t/ha gave the highest plant height and number of branches per plant (Table 5). Dry matter of plant fractions were significantly increased being higher in all poultry manure treated plots than those not treated with poultry manure (Table 6). Utasi (*Gongronema latifolium)* growth rate recorded as dry matter accumulation ($g/m^2/day$) in leaf, stem and root was significantly higher in poultry manure plots as compared with where poultry manure was not applied (Table 7). The highest leaf and stem dry matter growth rate was obtained in plots that received 4.5t/ha poultry manure in the two cropping seasons (2017and 2018). Fresh leafyield per hectare increased significantly with increases in poultry manure rate up to 3.5t/ha beyond this rate, the yield began to decrease (Table 9).

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The effects of planting distance on plant height, number of leaves and branches per plant presented in Table 5, shows that narrow planting distance significantly reduced the number of leaves and branches per plant. Closer planting distance of 100 x 40 cm gave taller utasi plants with fewer number of leaves and branches per plant compare with other wider planting distance. Higher leaf area index value was obtained in plants in narrow planting distance plots as compare to those of wider planting distance (Table 5). On the other hand, dry matter of plant fractions (leaf, stem and root) dry weight per plant was significantly higher in wider row planting distance than the narrow row planting distance (Table 6). At all periods of measurements either at 6 weeks after planting (WAP) or 50% anthesis plants cultivated in wider rows planting distance of 100 x 100cm consistently produced the highest dry matter weight of leaf, stem and root per plant in both 2017 and 2018 cropping seasons respectively. The effects of planting distance on leaf, stem and root growth rate closely follow the same trend as their effects on dry matter of plant fractions, where the wider planting distance recorded higher leaf ,stem and root growth rate than narrow planting distance. The highest leaf ,stem and root growth rate at 6 WAP and 50% anthesis were observed in wider planting distance of 100 x 100cm in the two cropping seasons (2017 and 2018) respectively. Results indicated that wider planting distance produced significantly higher Utasi*Gongronema latifolium* fresh leaf yield per plant than narrow planting distance (Table 9). However, on per hectare basis, narrow planting distance gave higher fresh leaves yield than wider planting distance . The narrow planting distance of 100 x 40cm produced significantly the highest fresh and dry leaf yield per hectare in the two seasons (2018 and 2019).

Poultry manure and planting distance interactions

There was significant interaction between poultry manure and planting distance in most of the vegetative growth parameters measured (leaf number, dry matter of plant fractions and their growth rate) (Table 8). Results showed that at all periods of measurements (6 WAP and 50% anthsis) number of leaves, dry matter of plant fractions and their growth rate were significantly higher in closer intra rows spacing plots treated with 4.5t/ha as compare with other plots planting distance and poultry manure rates treatments. The highest *Gongronema latifolium* fresh leaves yield at 21 WAP (151.37g in 2017 and 153.42g in 2018) and dry leaf yield (60.55g in 2017, and 61.28g in 2018) yield per plant were obtained in wider intra row spacing of 100 x 100cm that received 3.5t/ha, poultry manure at 21 weeks after planting (Table 10) while the closer inter row spacing of 100 x 40cm that received 3.5t/ha poultry manure produced the highest fresh leaves yield of (3.512t/ha in 2017 and 3.613 t/ha in 2018) and dry leaf yield of (0.788t/ha in 2017 and 0.986 t/ha in 2018) yield per hectare in both cropping seasons (2017 and 2018).

DISCUSSION

The weather condition of the study area obtained from the meteorological station showed that the average rainfall, relative humidity, atmospheric temperature and relative temperature were high enough to support plant growth throughout the cropping seasons (2017 and 2018). The analyzed result of the soil of the experimental sites revealed that the soil was sandy loam, acidic, and low in organic matter and soil nutrients. Therefore, it require the application of organic manure and soil amendment materials to improve it fertility status for increased crop yield. Essoka*et al*,2014 have recommended the application of soil amendment materials (poultry manure or rice husk) to soils that have low nutrients so as to increase their fertility status for high crops yield.

The application of poultry manure significantly resulted in higher growth and yield parameters of *Gongronema latifoluim* than the control where manure was not applied. In this study, effects of seasons do not showed any significant difference on the performance (growth and yield parameters) of *Gongronema latifoluim*. The absence ofsignificant performance variation withrefrence to growth parameters in the two seasons (2017 and 2018) may probably be due to the similar weather conditions and quality of the poultry manure used in both seasons. The significant higher plant height, number of leaves, braches and leaf area index produced in plots that were treated with 4.5 t/ha poultry manure rate could be attributed to the essential nutrient elements present in poultry manure that increased the photosynthetic activities of Utasi (*Gongronema latifoluim)* crop .This findings confirmed the works of Awodun (2007) who reported significant increased n plant height and number of leaves as a result of poultry manure application.

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The observed greater increased in dry matter of leaf , stem and their growth rate recorded at 4.5t/ha poultry manure as compared to lower rate of poultry manure could be due to the ability of poultry manure to produce nutrients necessary for crop growth. The supplied nutrients elements by poultry manure could have enhance more growth through increased physiological activities and growth. The application of 3.5t/ha poultry manure seemed most appropriate for highest leave yield of *Gongronema latifolium*. This rate of poultry manure produced the highest dry matter yield of 2.648, and 2.745 t/ha at 21 Weeks after planting in 2017 and 2018 cropping seasons respectively . Beyond this rate 3.5t/ha poultry manure increases had no additional benefits in boasting fresh and dry leaf yield of *Gongronema latifolium* under Obubra growing conditions of South, South Agro ecological zone.

The significantly decreased in the number of leaves per plant in closer intra-row spacing could probably be due to high intraspecific competition for the available growth resources by plants in the closer row spacing. This result agreed with Ijoya*et al* (2012) who reported that closer row spacing result in poor vegetative growth such as number of leaves and branches per plant compared to the wider row spacing.

The increased in leaf and stem dry weight per plant observed in wider row (100 x 80cm and 100 x100cm) possibly imply that these spacing are adequate for soil moisture and nutrients requirements of *Gongronema latifolium* biomass production . This could be due to positive effect of wider inter-row spacing where there is minimum competition for growth resources between plants compare to closer row spacing in that the photosynthetic efficiency of plants increased and the plants utilized the sufficiently available resources . The result is in agreement with Udom, *et al;* (2016) who noted increased in dry matter of plant leaf and stem in wide intra row spacing and concluded that wide rows spacing could increase individual plant growth performance especially morphological growth attributes such as leaves braches and shoots in vegetables. The reduce number of leaves , dry weight of leaf and stem recorded in close intra row plant spacing could be attributed to intra specific completion of individual plant for growth resources such as available water, light, nutrients and even space.

The increased in fresh and dry leaf yield per hectare obtained within closer intra row spaced plant (100 x 40cm) followed by 100 x 60cm could probably be due to the higher leaf area index value developed by *Gongronema latifolium*Plants in these plots.

This enhanced earlier ground cover by the leaves of plants in these plots that facilitate adequate harvest of solar radiation resulted to higher photosynthetic efficiency and consequently higher yield. Earlier researchers in planting distance that work at the same geographical location similarly reported increased in fresh and dry leaf yield per hectare in narrowly spaced plants plots. (Orluchukwu and Nunee (2016),Udosen, *et al* (2016)).

The lowest fresh and dry leaf yield from 100 x 100cm plant spacing, could be due to the wide planting distance with few number of plants that were not high enough to compensate for the loss of soil area associated with lower plant population densities.

This result is in conformity with the findings of Kashasay*et al* (2014) where wider intra row spacing gave the lowest total yield as against those obtained at narrow row spacing.

CONCLUSION

Based on the findings of this study the use of 100 x 40cm planting distance when accompanied with the application of 3.5t/ha poultry manure would enhanced optimum growth and yield of Utasi(*Gongronema lactifolium*) in *in tropical ultisol* soil.

RECOMMENDATION

Farmers are advised to cultivate Utasi(*Gongronema lactifolium)* at the plating distance of either 100 x 40cm, 100 x 60 cm or use these plating distances with the application of 3.5t/ha poultry manure for optimum growth and yield in a tropical utisol of Obubra South-Soulth , Nigeria.

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Table 2. Meteorological data of the study sites during 2017 and 2018 cropping seasons.

	April		May		June		July		August		September		October		November		TOTAL		MEAN	
Weather Parameters																				
Temperature(^{0}C)	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Minimum	24.8	23.7	24.5	24.2	23.3	23.1	22.4	21.3	24.6	23.7	22.5	21.4	22.3	20.8	20.2	20.1	184.6	178.3	23.08	22.29
Maximums	33.7	32.9	32.2	31.4	31.4	32.5	30.3	31.3	32.4	32.1	31.3	30.2	30.5	30.2	29.4	28.5	251.2	218.9	31.4	27.36
Rainfall (mm)	196.4	235.5	46.7	304.3	361.7	414.6	506.32	613.2	275.7	296.8	308.7	345.5	278.5	02.3	102.4	151.2	2276.4	2663.4	284.55	332.93
Relative Humidity(%)	75.4	77.3	76.5	79.6	85 .2	79.8	87.3	88.5	76.7	78.5	81.3	83.4	78.8	77.8	77.4	77.3	638.6	79.83	642.2	80.28

Table 3. Soil physical and chemical properties of the experimental sites before planting and after harvesting of *Mucunaflagellipes* in 2017 and 2018 cropping seasons.

Physical properties	**Before planting**		**After harvesting**	
	2017	**2018**	**2017**	**2018**
Mechanical properties				
Coarse sand (%)	17.3	17.2	17.1	17.4
Fine sand (%)	65.4	65.8	65.5	66.1
Silt (%)	6.2	6.4	6.4	6.3
Clay (%)	16.5	16.7	17.3	18.3
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Chemical Properties				
pH in water	5.04	5.03	5.12	5.13
pH in KCl	4.03	4.02	4.15	4.16
Organic carbon (%)	0.76	0.78	0.97	0.98
Organic matter (%)	1.22	1.23	1.89	1.87
Nitrogen (%)	0.07	0.08	0.24	0.25
Available phosphorus (Cmol/kg)	6.7	6.8	7.3	7.5
Base saturation (%)	68.4	67.8	68.2	68.4
Exchangeable cation (cmol/kg)				
Potassium	0.15	0.16	0.19	0.19
Magnesium	1.7	1.8	2.53	2.61
Calcium	2.5	2.6	3.01	3.04
Sodium	0.08	0.07	0.13	0.14
Exchangeable Acidity(Ea)(Cmol/kg)				
Aluminum	1.7	1.8	1.79	1.78
Hydrogen	2.3	2.4	2.05	2.01
Cation Exchange Capacity (%)	8.63	8.65	8.72	8.69

Table 4. Chemical composition of the poultry manure used in this studies 2017 and 2018 cropping seasons.

Nutrient	Content (%)	[xx]Reported range (%)
Magnesium	2.02	1.54 – 2.96
Calcium	6.23	1.2 – 4.40
Potassium	1.31	0.90 – 2.17
Nitrogen	1.96	2.17 – 3.50
Phosphorus	1.32	0.18 - 1.68
Organic carbon	50.42	27.43-46.70
Organic matter	24.37	40.35-70.20

[xx]Range reported by Dauda *et al* ; (2008) from analysis of poultry manure.

Table 5. Effects of poultry manure and Planting Distance on plant height(cm l number of leaves, branches, leaf Area Index (LAI) on Utasi (*Gongronema lactifolium)* in 2017 and 2018 cropping seasons.

	Number of leaves Per plant				Leaf Area Index(LAI)				Number of Branches Per plant				Plant height (cm)			
Planting Distance (cm)	2017		2018		2017		2018		2017		2018		2017		2018	
	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50%Athesis	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50% Anthesis
100x 40	5.1	18.2	5.3	19.1	0.0045	2.3321	0.0043	2.3182	1.0	3.1	1.0	3.2	93.89	234.24	95.19	240.23
100 x60	6.2	23.3	6.3	25.2	0.0034	2.1023	0.0056	2.0116	1.0	4.2	1.0	4.3	81.47	206.55	84.37	211.12
100 x80	7.3	31.4	7.4	33.3	0.0025	1.6953	0.0037	1.7183	1.1	4.4	1.1	5.2	67.64	183.47	63.85	193.13
100x 100	8.4	36.2	8.5	38.4	0.0016	1.4036	0.0043	1.3425	1.0	6.2	1.0	7.3	54.23	161.68	56.99	174.57
LSD(0.05)S	0.01	3.1	0.02	3.3	0.001	0.020	0.001	0.020	NS	0.03	NS	0.04	5.2	6.3	5.2	7.1
Poultry manure Rate(t/ha)																
0	5.1	16,2	5.3	19.3	0.0034	1.1708	0.0026	1.1900	1.0	3.1	1.0	3.2	99.89	234.24	95.23	240.23
1.0	6.3	26.3	6.2	27.2	0.0032	1.6123	0.0039	1.5687	1.0	5.1	1.0	4.2	123.56	252.68	129.76	250.98
2.5	7.3	36.2	7.4	38.4	0.0063	2.1045	0.0073	2.0121	1.0	6.2	1.0	6.4	136.32	265 .72	139.32	200.51
3.5	8.2	40.3	8.3	41.1	0.0074	2.8014	0.00l84	2.795	1.1	7.3	1.1	8.3	151.74	283.35	149.84	279.63
4.5	8.5	46.4	8.5	49.3	0.0132	3.2965	0.00137	3.287	1.0	9.4	1.0	9.3	168.49	314.51	174.46	308.97
LSD(0.05)	0.02	4.2	0.03	4.5	0.001	0.023	0.001	0.031	NS	0.05	NS	0.06	5.2	6.2	7.3	8.4

Note: F- LSD(0.05) Fishers Least Significant Difference at 5% probability level, NS =Non significant at 5% probability level,

Table 6. Effects of poultry manure and planting Distance on Dry matter of plant fractions (leaf, stem and root dry weight per plant) at 6 weeks after plant and 50% Anthesis on Utasi (*Gongronema lactifolium*) in 2017 and 2018 cropping seasons.

	Leaves dry weight Per plant (g)				**Stem dry weight Per plant (g)**				**Root dry weight Per plant (g)**			
Planting Distance cm)	**2017**		**2018**		**2017**		**2018**		**2017**		**2018**	
	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50%WAP	6WAP	50%Anthesis	6WAP	50%Anthesis	6WAP	50%Anthesis
100 x 40	15.32	34.21	16.32	31.78	10.41	22.23	11.41	20.28	2.34	24.31	2.53	21.45
100 x 60	20.32	41.36	22.44	43.27	14.32	31.56	15.22	33.35	2.59	36.24	2.47	38.42
100 x 80	26.94	50.43	28.17	52.48	17.57	40.46	19.31	43.21	2.27	43.35	2.71	47.48
100 x 100	34.36	63.18	37.35	62.57	21.49	49.98	24.13	50.17	2.79	55.56	2.38	59.39
LSD(0.05)S	2.3	4.2	2.5	3.4	1.2	2.6	1.3	3.2	NS	2.4	NS	2.5
Poultry manure Rate(t/ha)												
M												
0	15.28	34.35	16.43	31.83	10.41	22.23	11.41	20..30	2.34	24.32	2.51	21.43
1.0	28.76	53.28	29.26	55.38	17.42	37.32	18.16	35.17	3.37	33.85	2.61	35.87
2.5	34.29	61.36	32.45	65.37	22.19	49.54	21.21	45.28	4.87	45.21	2.53	49.24
3.5	39.84	73.54	41.78	70.26	34.26	54.37	28.31	52.34	6.31	52.43	2.49	56.96
4.5	43.27	84.27	48.32	82.33	40.74	67.15	33.24	61.74	8.53	63.89	2.76	67.24
LSD(0.05)	3.7	5.1	2.2	5.4	4.1	6.2	1.4	3.5	0.51	2.1	NS	2.4

Table 7. Effects of poultry manure and Planting Distance on leaf, stem and root growth rate ($g/m^2/day$) of Utasi (*Gongronema lactifolium*) in 2017 and 2018 cropping seasons.

	Leaf growth Rate ($g/m^2/day$)						**Stem growth Rate ($g/m^2/day$)**						**Root growth Rate ($g/m^2/day$)**					
Planting Distace(cm)	**2017**			**2018**			**2017**			**2018**			**2017**			**2018**		
	21-45DAP	45-70DAP	70-125DAP	21-45DAP	45-70DAP	70-125DAP	21-45DAP	45-70DAP	70-125DAP	21-45DAP	45-70DAP	70-125DAP	21-45DAP	45-70DAP	70-125DAP	21-45DAP	45-70DAP	70-125DAP
100x 40	0.0025	0.0412	0.2431	0.0026	0.0410	0.2442	0.0011	0.0024	0.0471	0.0012	0.0023	0.0483	0.0001	0.0016	0.0223	0.0001	0.0015	0.0225
100 x60	0.0028	0.0634	0.4578	0.0027	0.0643	0.4632	0.0014	0.0031	0.0786	0.0016	0.0034	0.0792	0.0002	0.0019	0.0346	0.0002	0.0021	0.0357
100 x80	0.0031	0.0757	0.6893	0.0034	0.0759	0.6798	0.0018	0.0053	0.0953	0.0017	0.0056	0.1120	0.0002	0.0023	0.0667	0.0002	0.0022	0.0685
100x 100	0.0034	0.0936	0.1354	0.0037	0.0942	0.1467	0.0023	0.0086	0.1145	0.0024	0.0088	0.1352	0.0003	0.0026	0.0783	0.0002	0.0028	0.0849
LSD(0.05)	0.0001	0.002	0.012	0.0001	0.002	0.013	0.0001	0.001	0.01	0.001	0.001	0.01	NS	0.001	0.002	NS	0.001	0.002
Poultry Manure Rate(t /ha)																		
0	0.0025	0.0413	0.2432	0.0414	0.0415	0.2443	0.0011	0.0057	0.0471	0.0012	0.0468	0.0483	0.0001	0.0016	0.0223	0.0001	0.0015	0.0225
1.0	0.0029	0.0721	0.6764	0.0031	0.0732	0.6822	0.0015	0.0089	0.0898	0.0017	0.0877	0.0914	0.0004	0.0025	0.0412	0.0005	0.0026	0.0469
2.5	0.0035	0.0843	0.9564	0.0037	0.0841	0.9744	0.0018	0.0154	0.1328	0.022	0.1415	0.1517	0.0007	0.0028	0.0835	0.0008	0.0030	0.0798
3.5	0.0038	0.1252	1.2134	0.0038	0.1324	1.3221	0.0019	0.0178	0.1597	0.025	0.1785	0.1865	0.0009	0.0029	0.1205	0.0009	0.0031	0.1251
4.5	0.0043	0.1437	1.5786	0.0045	0.1523	1.7743	0.0024	0.0234	0.8545	0.027	0.8977	0.9858	0.0015	0.0032	0.1537	0.0018	0.0034	0.1452
LSD(0.05)	0.0002	0.003	0.014	0.0002	0.003	0.016	0.0002	0.002	0.03	0.006	0.04	0.04	0.0001	0.003	0.004	0.0002	0.003	0.005

Table 8 A.. Main Interaction Effects of poultry manure and planting Distance on plant height, leaf and branches number, dry matter of leaf and stem per plant(g) of Utasi (*Gongronema lactifolium)* in 2017 and 2018 cropping seasons.

Poutry Manure(P) x plant Distance(S)Interacton (P x S)	**No. of leaves per plant**				**Leaf Area Index (LAI)**				**Leaf Dry Weight per plant (g)**				**Leaf Growth Rate (g/m2/day)**				**Stem Growth Rate (g/m2/day**			
	2017		2018		2017		2018		2017		2018		2017		2018		2017		2018	
	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis	6WAP	50% Anthsis
P0S1	5.1	18.2	5.3	19.1	0.045	2.332	0.0043	2.318	15.32	34.21	16.32	31.78	0.0023	0.1753	0.002	0.1685	0.0011	0.0412	0.0012	0.0452
P0 S2	6.2	21.1	6.1	20.3	0.0034	2.1023	0.0034	2.0116	20.32	41.36	22.44	43.27	0.0043	0.2124	0.0041	0.234	0.0016	0.0632	0.0016	0.068
P0S3	6.3	23.3	6.2	24.2	0.0025	1.6953	0.0027	1.7183	26.94	50.43	28.17	52.48	0.0052	0.3241	0.0046	0.3162	0.0018	0.0752	0.0019	0.075
P0S4	7.1	25.2	7.2	26.1	0.0016	1.4086	0.0015	1.3425	34.36	63.18	37.35	62.57	0.0061	0.4347	0.00666	0.4274	0.0013	0.0816	0.0014	0.0843
P1S1	6.3	21.3	6.2	22.3	0.0075	2.8964	0.0067	2.8752	23.12	37.68	18.13	34.34	0.0053	0.3728	0.0055	0.3831	0.0015	0.0931	0.0016	0.068
P1S2	7.1	26.2	7.2	25.2	0.0062	2.7659	0.0054	2.7124	28.45	46.74	25.42	47.26	0.0074	0.4578	0.0069	0.5386	0.0096	0.1213	0.0098	0.095
P1S3	7.1	29.1	7.3	28.3	0.0056	1.6543	00.43	1.6645	33.57	50.39	34.73	49.66	0.0079	0.5155	0.0078	0.5432	0.0132	0.1453	0.125	0.108
P1S4	8.2	31.4	8.3	30.2	0.0034	1.4437	0.0032	1.4578	37.36	55.16	35.58	53.84	0.0085	0.5621	0.0084	0.5735	0.0154	0.1657	0.14	0.1386
P21S1	6.4	26.2	6.2	25.1	0.0098	2.9724	0.0094	2.9854	39.23	53.75	36.44	54.39	0.0047	0.4745	0.0045	0.4576	0.0105	0.126	0.1073	0.0986
P2S2	7.3	29.1	7.2	29.3	0.0084	2..8625	0.0087	2.8591	43.42	60.38	40.65	61.27	0.0085	0.5531.	0.0083	0.5612	0.0213	0.1752	0.0211	0.1423
P2S3	8.1	35.3	8.3	34.1	0.0079	2.6112	0.0077	2.631	48.32	65.46	45.29	67.58	0.0089	0.6053	0.0086	0.6210	0.0251	0.1913	0.0248	0.1879
P2S4	8.4	38.2	9.1	39.2	0.0053	2..5437	0.0048	2.437	51.11	71.86	49.52	72.68	0.014	0.7532	0.0162	0.7721	0.0273	0.2312	0.0281	0.2444
P3S1	6.3	28.1	6.1	27.3	0.0187	3.4685	0.019	3.512	39.24	57.37	36.39	54.46	0.023	0.5327	0.0234	0.5162	0.0204	0.1582	0.207	0.1986

P3S2	7.2	36.2	7.1	35.3	0.0162	3.3012	0.017	3.0984	46.13	64.91	43.22	61.78	0.029	0.6435	0.0252	0.6394	0.0261	0.2019	0.02437	0.2168
P3S3	8.3	40.3	8.2	41.1	0.0156	3.1728	0.014	3.076	52.22	70.57	51.86	72.47	0.0352	0.6894	0.0331	0.6934	0.0342	0.2537	0.02976	0.2438
P3S4	9.3	45.2	9.2	47.2	0.0145	2.8534	0.013	2.836	57.64	76.89	56.47	77.58	0.0455	0.7537	0.04623	0.7571	0.0415	0.4341	0.03634	0.4021
P4S1	6.4	32.1	6.3	31.3	0.0298	4.3219	0.0293	4.0142	49.45	63.41	47.25	61.96	0.0367	0.5512	0.0315	0.5617	0.0361	0.2123	0.0301	0.3245
P4S2	7.3	44.1	7.2	45.2	0.0273	3.6582	0.275	3.8253	53.23	73.35	54.34	70.68	0.039	0.6475	0.0411	0.6712	0.0435	0.3214	0.0385	0.4012
P4S3	10.2	53	9.4	50.4	0.0263	3.3428	0.0268	3.4359	55.13	80.45	53.86	82.35	0.056	0.7865	0.05812	0.8034	0.04812	0.4315	0.04263	0.5157
P4S4	11.3	63.	11.2	67.3	0.0255	2.9843	0.2384	2.8231	58	87.59	60.22	89.65	0.087	0.9654	0.0863	0.9874	0.0525	0.6275	0.04923	0.5057
LSD(0.05)	0.01	1.2	0.02	1.4	0.001	0.021	0.001	0.022	1.51	2.12	1.20	2.14	0.002	0.04	0.00`2	0.044	0.01	0.02	0.01	0.02

NOTE: F- LSD(0.05) Fishers Least Significant Difference at 5% probability level, P0S1= 0 t/ha poultry manure + plant spacing of 100 x 40cm, P0 S2 = 0t /ha poultry manure + 100 x 60cm, P0 S3 = 0t/ha poultry manure + 100 x 80cm, P0 S4 = 0t/ha poultry manure + 100 x 100cm, P1S1 = 1t/ha Poultry manure + 100 x 40cm, P1S2 = 1t/ha Poultry manure + 100 x 60cm, P1S3 = 1t/ha Poultry manure + 100 x 80cm, P1S4 = 1t/ha Poultry manure + 100 x 100cm, P2S1 = 2.5t/ha Poultry manure + 100 x 40cm, P2S2 = 2.5t/ha Poultry manure + 100 x 60cm, P2S3 = 2.5t/ha Poultry manure + 100 x 80cm, P2S4 = 2.5t/ha Poultry manure + 100 x 100cm, P3S1 = 3.5t/ha Poultry manure + 100 x 40cm, P3S2 = 3.5t/ha Poultry manure + 100 x 60cm, P3S4 = 3.5t/ha Poultry manure + 100 x 100cm, P4S1 = 4.5t/ha Poultry manure + 100 x 40cm, P4S2 = 4.5t/ha Poultry manure + 100 x 60cm, P4S3 = 4.5t/ha Poultry manure + 100 x 80cm, P4S4 = 4.5t/ha Poultry manure + 100 x 100cm.

Plant spacing	Fresh leaves Yield per plant (g)						Fresh leaves Yield per Hectare (t/ha)						Dry leaves Yield per plant (g)						Dry leaves Yield per hectare (t/ha)					
	2017			2018			2017			2018			2017			2018			2017			2018		
	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP
100x 40	34.67	55.71	76.54	36.32	53.78	78.36	0.436	0.765	2.539	0.423	0.789	2.339	10.33	21.14	35.31	11.21	20.42	31.13	0.337	0.845	1..438	0.329	0.847	0.754
100 x60	41.38	67.45	98.69	44.47	65.46	99.79	0.324	0.653	2.032	0.337	0.675	2.013	12.54	29.58	42.25	12.35	31.35	44.25	0.212	0.756	1.210	0.214	0.758	0.642
100 x80	52.43	71.38	121.54	54.35	74.25	126..47	0.248	0.486	1.513	0.235	0.494	1.313	13.42	34.76	54.12	14.13	36.16	53.17	0.187	0.545	0.823	0.185	0..553	0.465
100x 100	74.29	96.74	158.35	76.13	97.58	164.69	0.137	0.373	1.047	0.128	0.369	1.027	16.27	47.37	63.32	16.32	46.47	62.25	0.126	0.437	0.743	0.128	0.448	0.346
LSD(0.05)S	2.1	3.3	4.3	2.2	3.2	5.1	0.01	0.02	0.04	0.02	0.03	0.05	0.4	1.3	2.4	0.3	1.4	2.1	0.01	0.03	0.05	0.01	0.04	0.02
Poultry manure Rate(t/ha)																								
0	34.67	55.71	76.54	36.32	53.78	81.36	0.143	0.325	0.436	0.146	0.341	0.454	10.13	21.14	35.31	11.21	20.42	31.13	0.337	0.541	0.643	0.343	0..552	0.648
1.0	46.21	73.49	100.71	48.54	69.83	112.53	0.245	0.527	0.824	0.248	0.543	0.841	13,57	33.35	47.86	13.75	32.96	49.34	0.489	0.765	0.956	0.486	0.771	0.961
2.5	59.32	84.63	118.52	61.41	87.56	131.36	0.368	0.710	1.475	0.375	0.762	1.534	15.33	39.74	58.28	15.33	39.79	58.52	0.658	0.875	1.126	0.663	0.885	1.132
3.5	82.45	99.78	168.78	85.11	100.35	174.27	0.501	0.859	2.648	0.382	0.874	2.745	17.24	48.23	76.89	16.95	56.34	78.43	0.812	1.058	1.635	0.823	1.071	1.652
4.5	70.25	80.34	102.34	68.95	86.21	90.63	0.353	0.432	1.024	0.357	0.446	1.081	14.13	34.15	55.32	17.78	36/42	53.32	0.473	0.642	0.879	0.469	0.654	0.895
LSD(0.05)	2.4	3.6	6.4	4.1	5.2	6.2	0.02	0.03	0.05	0.02	0.03	0.05	0.73	1.6	3.0	0.5	1.7	3.1	0.01	0.03	0.05	0.01	0.03	0.05

Table 9. Effects of poultry manure and Plant spacing on yield of Utasi (*Gongronema lactifolium*) in 2017 and 2018 cropping seasons.

Table 10. Main interaction Effects of poultry manure and Plant spacing on yield of Utasi (*Gongronema lactifolium*) in 2017 and 2018 cropping seasons.

Plant spacing	Fresh leaves Yield per plant (g)						Fresh leaves Yield per Hectare (t/ha)						Dry leaves Yield per plant (g)						Dry leaves Yield per hectaret (t/ha)					
	2017			2018			2017			2018			2017			2018			2017			2018		
	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	9WAP	15WAP	21WAP	8WAP	14WAP	20WAP
P0S1	34.67	55.71	76.54	36.32	53.78	78.36	0.436	0.765	2.339	0.423	0.789	2.479	10.33	21.14	35.31	11.21	20.42	31.13	0.337	0.845	0.754	0.36 6	0.874	0.772
P0 S2	37.26	64.32	82.34	42.18	64.59	99.79	0.324	0.653	2.013	0.337	0.675	2.057	12.54	29.58	42.25	12.35	31.35	44.25	0.212	0.756	0.642	0.234	0.768	0.652
P0S3	50.53	70.46	93.12	49,45	75.34	126..4 7	0.248	0.486	1.313	0.235	0.494	1.618	13.42	34.76	54.12	14.13	36.16	53.17	0.187	0.545	0.465	0.184	0.553	0.459
P0S4	76.32	84.75	101.36	75.46	98.42	164.69	0.137	0.373	1.027	0.128	0.369	1.051	16.27	43.37	63.32	16.32	46.47	62.25	0.126	0.437	0.346	0.132	0.445	0.47
P1S1	38.38	59.24	79.28	36.83	58.94	82.32	0.489	0.889	2.589	0.487	0.892	2.611	12.42	24.31	38.64	12.21	23.15	36.79	0.487	0.902	0.875	0.489	0.905	0.869
P1S2	48.25	70.33	87.34	46.39	72.43	89.56	0.375	0.768	2.238	0.356	0.769	2.242	14.37	35.59	43.47	13.87	36.34	45.37	0.376	0.876	0.762	0.379	0.883	0.771
P1S3	54.29	83.45	102.62	57.39	85.71	112.27	0.298	0.707	1.476	0.285	0.709	1486	15.86	47.42	51.23	16.32	46.57	50.25	0.308	0.804	0.643	0.305	0.812	0.651
P1S4	81.45	98.71	113.53	79.66	96..85	123.36	0.274	0.646	1.134	0.272	0.652	1.131	18.87	53.64	57.65	19.43	51.98	58.36	0.246	0.621	0.534	0.236	0.620	0.528
P2S1	40.25	60.33	80.74	41.53	63.24	84.52	0.579	0.965	2.687	0.567	0.968	2.746	13.84	25.82	37.14	14.31	24.37	36.97	0.689	0.953	0.859	0.675	0.965	0.864
P2S2	47.36	74.52	109.38	49.12	73.38	107.48	0.502	0.879	2.566	0.504	0.884	2.564	21.35	29.14	48.53	21.86	31.22	47.23	0.548	0.893	0.767	0.563	0.897	0.778
P2S3	59.52	87.44	124.27	60.23	85.68	126.27	0.467	0.848	1..63 3	0.468	0.852	1.712	24.68	50.33	54.87	23.65	51.36	55.42	0.502	0.776	0.658	0.533	0.784	0.678
P2S4	86.31	103.26	132.42	84.48	106.45	134.73	0.403	0.805	1.247	0.398	0.807	1.311	32.79	57.45	60.46	31.75	62.18	63.13	0.463	0.657	0.543	0.469	0.664	0.548
P3S1	46.12	72.79	85.31	47.41	71.58	86.54	0.776	1.439	3.512	0.781	1.443	3.613	16.34	28.39	31.68	17.54	30.43	32.26	0.786	1.409	0.988	0.789	1.417	0.986
P3S2	57.41	89.53	92.68	55.28	87.75	94.31	0.659	1.021	3.124	0.673	1.112	3.107	19.85	33.62	40.32	20.31	42.57	42.38	0.706	1.011	0.902	0.712	1.022	0.911
P3S3	62.25	100.21	142.49	67.37	102.34	147..2 2	0.618	0.911	2.789	0.619	0.901	2.791	23.18	41.11	49.73	24.25	50.41	50.47	0.657	0.879	0.653	0.668	0.876	0.649
P3S4	89.37	122.36	151.37	86.64	125.21	153.42	0.586	0.887	2.095	0.584	0.885	2.143	26.51	59.57	60.55	17.42	58.98	61.28	0.515	0.764	0.643	0.523	0.771	0.647
P4S1	58.16	61.34	96.15	56.45	63.11	94.35	0.608	0.868	1.527	0.609	0.864	1.517	29.76	30.35	36.22	29.33	31.79	37.12	0.681	0.782	0.520	0.688	0.783	0.536
P4S2	63.27	75.48	113.67	64.33	74.58	121.75	0.579	0.775	1.353	0.586	0.769	1.348	31.47	35.64	40.89	32.46	34.43	43.61	0.587	0.705	0.475	0.589	0.705	0.479
P4S3	93.43	132.79	153.41	92.78	156.36	158.45	0.518	0.703	1.148	0.519	0.705	1.139	39.68	61.26	70.32	39.11	63.32	68.59	0.501	0..64 8	0.357	0.512	0.653	0.658
P4S4	73.63	97.86	140.24	74.52	142.47	138.64	0.473	0.646	0.823	0.475	0.481	0.897	35.21	50.53	48.79	34.32	51.47	50.43	0.432	0.513	0.308	0.438	0.523	0.312
LSD(0.05)	3.11	4.21	4.7	5.0	4.1	5.3	0.01	0.02	0.03	0.01	0.02	0.03	1.3	2.1	2.4	1.1	2.2	3.0	0.01	0.02	0.01	0.01	0.02	0.01

NOTE: F- LSD(0.05) Fishers Least Significant Difference at 5% probability level, P0S1= 0 t/ha poultry manure + plant spacing of 100 x 40cm, P0 S2 = 0t /ha poultry manure + 100 x 60cm, P0 S3 = 0t/ha poultry manure + 100 x 80cm, P0 S4 = 0t/ha poultry manure + 100 x 100cm, P1S1 = 1t/ha Poultry manure + 100 x 40cm, P1S2 = 1t/ha Poultry manure + 100 x 60cm, P1S3 = 1t/ha Poultry manure + 100 x 80cm, P1S4 = 1t/ha Poultry manure + 100 x 100cm, P2S1 = 2.5t/ha Poultry manure + 100 x 40cm, P2S2 = 2.5t/ha Poultry manure + 100 x 60cm, P2S3 = 2.5t/ha Poultry manure + 100 x 80cm, P2S4 = 2.5t/ha Poultry manure + 100 x 100cm, P3S1 = 3.5t/ha Poultry manure + 100 x 40cm, P3S2 = 3.5t/ha Poultry manure + 100 x 60cm, P3S4 = 3.5t/ha Poultry manure + 100 x 100cm, P4S1 = 4.5t/ha Poultry manure + 100 x 40cm, P4S2 = 4.5t/ha Poultry manure + 100 x 60cm, P4S3 = 4.5t/ha Poultry manure + 100 x 80cm, P4S4 = 4.5t/ha Poultry manure + 100 x 100cm.