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Effects of Stem Cutting Length and Split Application of NPK Fertilizer on Growth and Yield of Waterleaf (Talinum Triangulare JACQ)

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Abstract:- The field experiment was conducted at the University of Uyo Teaching and Research Farm (Town campus) to investigate the effects of stem cutting length and split application of NPK fertilizer on growth and yield of waterleaf in 2015 and 2016 cropping seasons. The experiment was laid he experiment was a 6 x 4 factorial arranged in Randomized Complete Block Design with three replications. The factors under consideration included factor A (length of stem cutting) at different levels: 5, 6, 7, 8, 9 and 10 cm and factor B (split application of NPK fertilizer) including 200kg ha^{-1} (once), 100ha^{-1} (twice) and 50ha^{-1} (4 times) and the control. The results indicated significant differences (P< 0.05) on the growth and yield parameters assessed. Among the stem length treatments, the result showed significant increase in growth and yield from 5 cm stem cutting to 7 cm stem cutting. There was not significant increase in growth and yield from 7 cm stem cutting to 10 cm. The result showed that stem cutting of 10cm had 29% and 36% more number of leaves per plant compare to 5cm stem cutting, but only 1% and 6% when compared to 7 cm stem cutting. The 10 cm stem cutting had 1 -45% and 1-42% more number of branches in both cropping season than other treatments. The 10cm cutting also had significant foliar yield of 46% and 50% more than 5 cm cutting in both cropping seasons. When 10 cm cutting was compared to 7 cm, the percentage difference was 2% and 1%, respectively. The application of NPK stimulated vegetative growth and yield waterleaf. Split application of 50kg/ha (4 times) produced 19 – 78% and 21 – 76% more foliar yield than the other fertilizer treatments. The study therefore advised farmers to adopt 7cm cutting for vigorous growth and to avoid wastage of planting material. The split application of 50kg/ha (4 times) was recommended to waterleaf farmers.

Keywords:- *Waterleaf, Stem Cutting Length, Fertilizer and Split Application.*

I. INTRODUCTION

Waterleaf (*Talinum triangulare* Jacq) is a leaf vegetable that belongs to the family of Portulaceae (Udoh *et al.,* 2016). The Waterleaf, like most members of Portulaceae family can regenerate vegetatively stem cuttings and sexually by seeds (Jules, 1982; Akpan, 2011). Waterleaf is characterized by waxy leaves which are capable of water loss through evapo -transpiration. Waterleaf can branch profusely, a physiological adaptation that make it capable to survive spell or extended drought period due to its waxy nature. Waterleaf production is now a very popular and lucrative business in Nigeria due to its significance as major component of sauce, soup, yam, porridge, especially in southern Nigeria. It has some inherent characteristics which makes it attractive to small scale farmers, this include its short duration to harvest after planting which is about 20 – 30 days (Rice *et al.,* 1986). The demand for waterleaf is high in Southern Nigeria which including Akwa Ibom, Cross River, Delta, Imo, Abia etc. and it is a major source of income for farmers (Ndaeyo, *et al.,* 2013). Its high demand is attributed to its nutritional value and importance as a "softler" when cooking fibrous leaf vegetables such as *okazi* (*Gnetum africana*)and flute pumpkin (*Telfairia occidentalis*)

Recently, as the demand and cultivation of waterleaf rise, the planting materials become scarce. Most farmers now plant waterleaf with different length of stem cutting which invariably may results to differences in growth and foliar yield of waterleaf. Also, the harvesting of waterleaf is usually every two or three weeks, although some farmers do harvest at monthly interval. Adequate fertilizer application is required for optimum crop establishment, growth and regeneration of the foliage vegetables (Ikeh *et al.,* 2017). Often time, farmers do apply fertilizer once throughout the life span of waterleaf which range between 2 – 3 months. The high rainfall distribution is Akwa Ibom state which was estimated to about 2500mm per annum encourages soil erosion and leaching of nutrients. Leaching is one of the major challenges of fertilizer utilization in many coastal plain soils of Akwa Ibom state. Split application become one of the means of minimizing leaching. According to Shaviv (2001), a lack of synchronization between crop demands and N demands leads to low N-use efficiency. Split application may be a solution for this, but the

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application of slow release fertilizer has been found to be more effective. This fertilizer is composed of highly soluble urea pills coated with water insoluble material such as polyfin or sulfur which controls the pattern, rate, and duration of the N release (Shaviv, 2001). They have the advantage of saving labor and amount of N as well as reducing nitrous oxide emissions into the environment (Kondo et al., 2005). Therefore the alternative means of reducing soil nutrient leaching could be through splitting the application of fertilizer doses and apply at different intervals. The objectives of this study were to assess the effects of stem cutting length and split application on growth and yield of waterleaf in Uyo, southeastern Nigeria.

II. MATERIALS AND METHOD

The experiment was conducted at University of Uyo Teaching and Research Farm (Town campus) in Uyo, Akwa Ibom State in 2015 and 2016 cropping seasons. Uyo is located in the Southeastern part of Nigeria and is situated within the humid tropical rainforest zone. The Research Farm located at the latitude 5°18' and 5°28'N and longitude 7°26', and 7°57' E of equatorial region respectively with mean altitude of about 38.1m above sea level (Uyo Capital City Development, 1989). The mean annual rainfall is about 2115 mm with a mean monthly relatively humidity of 79.8%. The mean monthly temperature is about 26.88ºC (Meteorological Garden, 2008).

The entire experimental site was 96 m x 14 m (1344 m^2). The experimental design was randomized complete block design (RCBD) in 6 x 4 factorial combinations. The treatments were six (6) stem cutting lengths (5, 6, 7, 8, 9, 10 cm) and four fertilizer split application; 200kg/ha (once), 100kg/ha (2 times), 50kg/ha (4 times) and control (zero application). The experimental site was manually cleared with cutlass, spades and tilled with Indian hoe to break soil clods into particles.

The soil physic-chemical properties of the experimental site were as followed; soil pH (5.70), Organic matter (2.10%), total nitrogen (0.08%), available phosphorus (87 mg/kg), Ca, Mg and K were 2.75, 1.12 and 1.33 cmol/kg, respectively. The particle size distributions were; 86.70% (sand), 8.22% (Clay) and 5.08% (silt)

The soils were prepared into sunken seedbeds of 4 m x 2 m size. Planting was done October, 2015 and 2016. The planting distance used was 10 cm x 5 cm inter and intra row spacing, respectively. The field was irrigated with aid of watering can before planting. The planting method used was slanting. Watering was done once in every week from 4 weeks after planting (WAP) till at 9 weeks after planting (WAP). Watering can was used for the irrigation. The rate of water used weekly was 1500 mm per hectare. Weeding was done manually by hand pulling at monthly interval. Fertilizer (NPK-15:15:15) application started from 2 WAP base on treatment basis. The method of fertilizer application was broadcasting within the sunken seedbeds.

The following growth and yield parameters were determined; plant height, number of leaves per plant, number of branches per plant and total foliar yield in tons per hectare. All growth and yield parameters obtained were subjected to analysis of variance (ANOVA). Significant means were compared with least significant difference (LSD) at 5% probability level.

III. RESULTS

Waterleaf height as affected by length of stem cutting indicated significantly different ($P<0.05$) in both cropping seasons (Table 1). The result showed no significant difference ($P>0.05$) when stem cutting length of 7 cm was compared to 8, 9and 10 cm. At 12 weeks after planting (WAP), the 10cm stem cutting had 0.2 – 49.1% and 2 – 39% taller plants compared to the other treatments in both cropping seasons.

The significant differences recorded from increase in stem length from 5cm to 7cm with further increase in vegetative growth which was not significant difference ($P>0.05$) could be due to the longer cuttings might be that greater part of the cuttings were buried and more points were exposed which facilitated early establishment and rapid growth and more food reserves (dry matter accumulation). This observation agrees with the report of Peleyeju (2017) who reported significant increase in vegetative growth of sweet potato as source of leafy vegetable with increase in longer vines of 4 to 6 nodes.

Waterleaf height as influenced by split application of NPK fertilizer also varied significantly ($P<0.05$) in both cropping seasons. The tallest plant at 4 and 8 WAP was observed at plots of 200kg/ha while at 12 WAP, application of 100kg/ha (twice) and 50kg/ha (4 times) performed better than 200kg/ha (once). Among the fertilizer treatments, the control (no soil amendment) treatment had the shortest plant at 4, 8 and 12 WAP. The interaction effect between stem cutting and split application of NPK fertilizer were not significantly different at 4, 8 and 12 WAP, in both cropping seasons.

The shortest plant observed from the control treatment could be due to low soil nutrients content of the experimental site before planting. The soil had low organic matter, total nitrogen and exchangeable bases. This observation agrees with Ndaeyo et al (2013) and Ikeh et al (2015) that low nutrient reserve of most soils in the high humid zone of Nigeria limits crop growth and yield.

The split application of treatments performed better from 12 WAP could be that the dose of fertilizer applied later were better utilized on sustainable bases compared to applying the 200kg/ha at once which could have been lost as result of leaching within short period. The observation agrees with Ibia and Udo (2009) report that split application of organic and inorganic fertilizer enhances vegetable growth and yield in high humid ecological zone compared to sing application.

Number of leaves per plant as influenced by stem cutting length showed significant differences (P<0.05) at 4, 8 and 12 WAP, in both cropping seasons (Table 2). The increase in stem cutting length resulted to increase in production of higher number of leaves per plant. Comparing the results, there was no significant difference in number of leaves per plant when 7 cm stem cutting was compared to 8, 9 and 10 cm stem cutting. The 7 cm stem cutting had (18.81, 35.41 and 39.71 in 2015) and (13.12, 34.12 and 37.40 in 2016) at 4, 8 and 12 WAP, respectively while (14.20, 36.81 and 40.11 in 2015) and 14.22, 37.50 and 40.85 in 2016) respectively, was from 10 cm stem cutting. At 12 WAP, 10 cm stem cutting had 29% and 36% more number of leaves per plant compare to 5 cm stem cutting in 2015 and 2016 cropping seasons. The 10 cm stem cutting had only 1% and 8.6% number of leaves per plant when compared to 7 cm stem cutting.

The result showed no significant differences when 7cm stem cutting was compared to 8, 9 and 10 cm. This observation was in consonance with the report of Essilfe, *et al* (2016) in sweet potato propagules. Essilfe, *et al* (2016) reported no further significant difference in treatment of longer vines with 6 nodes per cutting when compared with 7 nodes per cutting. The longer cuttings may have more sprouting points compare to shorter stem cuttings which establish relatively slowly and this reflected to the lower number of leaves per plant, number of branches and shorter plants observed from the shorter stem cuttings.

Number of leaves per plant as affected by split application of NPK fertilizer also varied significantly in both cropping seasons (Table 2). At 4 and 8 WAP, the application of 200kg/ha (once) produced the highest number of leaves per plant. This was followed by the application of 100kg/ha (2 times). At 12 WAP, the application of 50kg/ha (4 times) produced the highest number of leaves per plant. In all the sample weeks, control (no soil amendment) treatment produced the least number of leaves per plant (Table 2). At 8 WAP, application of 200kg/ha (once) had 7-63% and 7 – 62% more number of leaves per plant compared to other treatments in both cropping seasons. At 12 WAP, the application of 50kg/ha (4 times) had 2 – 70% and 1 – 68% higher number of leaves per plant compared to the other treatments.

The interaction effect between stem cutting and split application of NPK fertilizer were not significant difference in both cropping seasons.

The significant response to fertilizer observed from the fertilized plots could be due to the low nutrients reserve of the experimental site. The increase in the growth and yield of waterleaf observed from the fertilized plots agrees with Akpan (2011) and Ndaeyo *et al.* (2013) reported increase in total output of waterleaf with application of fertilizer.

Number of branches per plant as affected by length of stem cutting was significantly different (P< 0.05) at 4, 8 and 12 WAP in both cropping seasons (Table 3). The result showed that stem cutting of 10 cm length had the highest number of branches per plant (Table 3), followed by 9 and 8 cm stem cuttings. The least number of branches per plant was from 5 cm stem cutting length. The result further indicated no significant difference (P<0.05) from7 cm stem cutting to 10 cm stem cutting in both cropping seasons. The stem cutting of 10cm length had 1 – 45% and 1 – 42% more number of branches per plant compared to other stem cutting lengths at 8 and 12 WAP, 2015. In 2016, it also had 0.1- 41% and 0.3 – 45% more number of branches than the other stem cuttings. Comparing the number of branches from 7 cm and 10 cm stem cuttings, the 10 cm stem cutting plots had (3% and 1%) and (4% and 5%) more number of branches at 8 and 12 WAP than 7 cm stem cutting in both cropping seasons. The significant number of leaves per plant observed from 5cm stem length to 7cm and no further significant increase from 7 to 10 cm length could be that 7 cm was the optimal length in which further increase in length could not have compensate further increase in vegetative growth and yield. This observation was in consonance with the observation Peleyeju (2017) where no significant increase in sweet potato growth and yield was observed between 5 and 6 nodes per stem cutting.

Numbers of branches per plant as influenced by split application of NPK fertilizer were significantly different at 4, 8 and 12 WAP in both cropping seasons (Table 3). The result maintains the similar trend as in the number of leaves per plant and plant height. The application of 200kg/ha (once) had (20 – 50 % and 7 – 49% in 2015) and (24 – 46% and 11- 55% in 2016) at 4 and 8 WAP. At 12 WAP, the application of 50kg/ha (4 times) produced 4 – 59% and 5 - 56 % more number of branched per plant compared to the other treatments in both cropping seasons.

The higher foliar yield obtained from 50kg/ha (4 times) could be that 4 times periodic application of NPK helps the crop to regenerate easily after harvesting and only few nutrients could have lost through the process of leaching. This observation agrees with application of nitrogen fertilizer at intervals helps to stimulate water leaf growth and yield.

Total foliar yield as affected by stem cutting length were significantly different (P<0.05) in both cropping seasons (Table 4). The result showed that 10 cm stem cutting produced the highest total foliar yield; 29.13 and 30.24 t/ha in 2015 and 2016 cropping seasons respectively. The stem cutting of 9 cm had 29.12 t/ha and 30.18 t/ha, respectively. The stem cutting of 7 cm had 28.45 t/ha and 30.09 t/ha, respectively. The least total foliar yield; 14.59 t/ha and 16.33 t/ha, respectively was from 5 cm stem cutting.

The 10 cm stem cutting produced 50% and 46% total foliar yield compared to 5 cm stem cutting in both cropping seasons. It had only 2% and 1% more total foliar yield in both cropping seasons when compared to 7 cm stem cutting.

Among the split fertilizer application, the result showed that application of 50kg/ha (4 times) produced the highest total foliar yield of 36.18 t/ha and 38.57 t/ha in 2015

and 2016 cropping seasons, respectively. This was followed by 29.50 t/ha and 30.40 t/ha from application of 100kg/ha (2 times). The application of 200kg/ha of NPK (once) produced 20.14 t/ha and 20.55 t/ha respectively. The least foliar yield; 8.12 t/ha and 9.11 t/ha respectively, was from the control. The application of 50kg/ha (4 times) produced 19 – 78% and 21 – 76% more than the other fertilizer treatments. Comparing the split application of 50kg/ha (4 times) and 200kg/ha (once), the result showed that 50kg/ha had 44% and 47% more total foliar yield compared to application of 200kg/ha (Once). The interaction between stem cutting length and split application of NPK on total foliar yield was not significant difference ($P>0.05$) in both cropping seasons.

The application of 200kg/ha of NPK (once) performed better than split application of 100kg/ha (2 times) and 50kg/ha (4 times) at 4 and 8 WAP, this could be due to high dose of essential nutrients which resulted in earlier vigorous growth. The decrease in growth and yield parameter with increase in sampling period in 200kg/ha (once) could be as a result of high level of leaching in the study area which associated with high amount of rainfall. The observation agrees with Ibia and Udo (2009) report that split application of organic and inorganic fertilizer enhances vegetable growth and yield in high humid ecological zone compared to sing application.

IV. CONCLUSION

The result of this investigation has shown that, indeed, the application of this innovative agricultural technology has many advantages in waterleaf production. It has great potential of sustainably increasing the foliar yield of waterleaf in humid ecology. It would also help to reduced leaching which is one of the major problem farmers in high humid zone of Nigeria is facing. Therefore the study advice waterleaf farmers to adopt stem cutting of 7 cm and split of 200kg/ha NPK into 4 times at rate of 50kg/ha at monthly interval.

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Table 1: Waterleaf Height (Cm) As Affected By Stem Cutting Length And Split Application Of Fertilizer

Treatment	**2015 Weeks after planting**			**2016 Weeks after planting**		
	4	8	12	4	8	12
Stem cutting length (cm)						
5	8.33	7.59	8.11	7.91	8.18	10.20
6	10.15	9.25	13.18	9.28	10.40	12.45
7	10.98	12.40	15.83	11.33	15.10	16.20
8	11.20	12.86	15.87	11.45	15.14	16.33
9	11.22	12.90	15.89	11.60	15.20	16.45
10	11.25	12.99	15.92	11.70	15.26	16.81
LSD (P<0.05)	**1.03**	**1.45**	**1.33**	**0.78**	**0.93**	**1.12**
Split Application (kg/ha)						
0	7.55	7.12	6.25	6.91	8.11	6.25
200 (once)	13.40	15.10	14.14	13.75	15.18	13.81
100 (2 times)	12.15	12.40	17.50	13.11	13.48	18.25
50 (4 times)	9.09	12.40	15.90	8.59	11.41	16.44
LSD (P<0.05)	2.14	2.91	3.48	2.01	2.99	2.80
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2:Number Of Waterleaf Leaves Per Plant As Affected By Stem Cutting Length And Split Application Of Fertilizer

Treatment	**2015 Weeks after planting**			**2016 Weeks after planting**		
	4	8	12	4	8	12
Stem cutting length (cm)						
5	10.20	19.33	28.40	10.33	18.55	26.11
6	13.40	28.40	30.11	12.10	30.11	30.14
7	13.81	35.41	39.71	13.12	34.12	38.40
8	13.90	35.97	39.80	13.20	36.01	38.50
9	14.01	36.01	39.90	14.18	37.40	40.22
10	14.20	36.81	40.11	14.22	37.50	40.85
LSD (P<0.05)	**0.85**	**1.85**	**2.17**	**2.33**	**3.59**	**3.64**
Split Application (kg/ha)						
0	8.50	13.59	12.70	9.06	15.08	16.22
200 (once)	15.15	36.75	37.18	18.25	39.50	42.40
100 (2 times)	14.30	34.30	41.30	17.15	36.80	49.60
50 (4 times)	12.40	30.11	42.11	16.33	34.18	50.18
LSD (P<0.05)	**2.18**	**3.01**	**3.41**	**2.24**	**3.13**	**5.17**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*NS= not significant

Table 3: Number Of Waterleaf Branches Per Plant As Affected By Stem Cutting Length And Split Application Of Fertilizer

Treatment	**2015 Weeks after planting**			**2016 Weeks after planting**		
	4	8	12	4	8	12
Stem cutting length (cm)						
5	4.10	6.22	6.90	4.18	6.25	6.89
6	5.59	7.11	9.40	5.12	7.30	9.59
7	6.75	10.89	11.77	6.79	10.20	11.90
8	7.11	10.66	11.81	6.99	10.51	11.92
9	7.78	11.14	11.90	7.40	10.66	12.45
10	8.16	11.25	11.92	7.77	10.67	12.49
LSD (P<0.05)	1.87	2.03	2.16	1.01	1.22	1.72
Split Application (kg/ha)						
0	6.25	6.90	7.11	6.10	7.01	8.06
200 (once)	12.40	13.40	13.55	11.25	15.40	14.68
100 (2 times)	9.90	12.45	16.70	8.55	13.74	17.40
50 (4 times)	8.85	12.14	17.45	7.82	12.99	18.30

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LSD (P<0.05)	**2.11**	**2.33**	**4.13**	**2.55**	**2.75**	**3.05**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*NS= not significant

Table 4: Foliar Yield (T/Ha) As Influenced By Stem Cutting Length And Split Application Of Fertilizer

Treatment	**2015**	**2016**
	Total foliar yield (t/ha)	**Total foliar yield (t/ha)**
Stem cutting length (cm)		
5	14.59	16.33
6	20.01	21.14
7	28.45	30.09
8	28.49	30.12
9	29.12	30.18
10	29.13	30.24
LSD (P<0.05)	**3.67**	**3.35**
Split Application (kg/ha)		
0	8.12	9.11
200 (once)	20.14	20.55
100 (2 times)	29.50	30.40
50 (4 times)	36.18	38.57
LSD (P<0.05)	2.44	3.24
Interaction	**NS**	**NS**

*NS= not significant