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Research Article

New Innovation of Vine Planting Pattern Effect on Growth and Tuber Yield of Sweet Potato, (Ipomoea batatas. L) Varieties.

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Abstract
The study was carried out at the Teaching and Research Farm of Federal University Wukari, Taraba State, Nigeria to evaluate the effect of vine pattern of planting on the growth and tuber yield of two sweet potato variety. The treatments consisted of two varieties of sweet potato namely white skin and Pink skin variety and four vine planting patterns indicated as direct vine planting, one ring, two rings and three rings vine planting. These were arranged in a Randomized Complete Block Design (RCBD) replicated three times. Data were collected on the growth and tuber yield parameters and analyzed using ANOVA and the differences among the treatment means was separated using Duncan Multiple Range Test as 5% level of probability. The results obtained showed that the vine planting pattern significantly affected the growth and tuber yield of the crop. The pink skin variety gave significantly highest primary vine length of (240.31cm), number of leaves (266.53) and number of nodes (446.56) while the white flesh variety had significantly higher number of secondary vines of (53.33cm). The two rings vine pattern planting produced significantly highest length of primary vine (331.56cm), number of secondary vine (47.39cm), number of leaves (728.17), number of nodes (694.44), best canopy coverage and leaf area of (131.32cm) The white skin variety produced significantly higher tuber weights of 2.76kg, width of tubers (38.15cm), and the length of tubers (22.0cm), while pink skin variety produced highest significant tuber number (8.5). The two rings and three rings vine patterns of planting exhibited similar influence on the yield of sweet potato (8.28kg and 8.11kg) respectively. Therefore, planting sweet potato using two rings vine planting pattern is best for the optimal production of sweet potato.

Keywords: sweet potato variety, vine length, tuber growth, tuber yield.

INTRODUCTION

Sweet potatoes (*Ipomoea batatas* (L) Lam) is an herbaceous dicotyledonous plant, which belongs to the family Convoluvlaceae. It is commonly called morning glory and it is the only member of the genus *Ipomoea* whose roots are edible (Wardell, 2006). It is widely grown in tropical, subtropical and warm temperate regions. It was originated in Central America and it was domesticated more than 5000 years ago. Currently, it is widely grown throughout the tropics and temperate region of the world. It is ranks among the fifth most important food crops after rice, wheat, maize and cassava and interestingly over 95% of the global sweet potato production is in developing countries. China is the largest grower of sweet potato, producing 80% of the world's supply (FAOSTAT, 2012; FAO, 2010; Jana, 1982) and Nigeria is the second largest producer of sweet potato in Africa and third in the world in 2009 (FAOSTAT, 2012). It is considered as a poor man's crop because of it low input requirement, ease of production and ability of produce under adverse weather and marginal soil condition (Aritua and Gibson, 2002). Most small-scale farmers in Africa and Asia used sweet potato, both the vegetative and storage roots as source of carbohydrate, protein, iron, fiber and vitamin A and C, for

human food (Wubanechi, 2014; Mohammed et al., 2012) and livestock feed (Yamakawa and Yoshimoto, 2012; Farrell et al., 2000). The edible tubers can be eaten boiled and fried or baked (Wubanechi, 2014). In Nigeria, presently packaged fried sweet potato chips are common in major cities of Portharcourt, Lagos, Umuahia, Ibadan and Abia. Various parts of the crop have been reported to contain both organic and mineral nutrients including vitamins A and C, Zinc(Zn), Potassium(K), Sodium(Na), Manganese(Mn), Calcium(Ca), Magnesium(Mg) and Iron(Fe) (Abubakar et al., 2010; Ukom et al., 2011). It has been observed that the few Nigerian farmers who engage in small scale sweet potato cultivation in some selected areas in the country face a myriad of problems such as low soil fertility and low tuber yield per land area on which the crop is grown. Availability of farm land is also decreasing rapidly as a result of increase in population and land tenure systems in Nigeria. Farmers are losing farm land each day and each year due to human activities such as building, road construction, creation of institution etc. Therefore, there is a need to increase yield of crops per unit land area to meet with the higher demand by man and industries. One of the ways out is to develop new innovations such as vine styles of planting that improve the tuber production of the plant per unit land. The ring style of vine planting is one of the new ways of increasing the tuber yield of sweet potato. The ring styles of planting provide nodes of 5 to 12 instead of 2 to 3 nodes from traditional direct plant method which resulted into more number of tubers per plant. Therefore, the vine style of planting should be an important point of focus because is a new innovation that improves the yields of potato tuber harvested per unit land area on farm land. The number of node buried can determine the number of tuber formation in sweet potato. Therefore, the new innovation of using a ring or two rings style of vine planting will increase the number of nodes buried between 5 to 12 into the soil and eventually increase the number of tuber formed and developed per unit plant.

Planting method used for a crop determines to a greater extent its performance in terms of growth and yield (Okhira *et al.*, 1987). Good planting methods when applied ensure a crop to have adequate opportunities to grow and express it to produce higher yield. Therefore, information is needed into the using of a ring or two rings style of vine planting methods adopted in potato planting and its effects on the growth, tuber yield and dry matter production. Hence the study was designed to evaluate the effect of vine planting methods on the growth and tuber yield of sweet potatoes (*Ipomea batatas*).

MATERIALS AND METHODS

Experimental site

This study was conducted at the teaching and research farm located at Federal University Wukari, Taraba State, Nigeria, and Wukari is a famous city located within Wukari local government area of Taraba state (formerly Gongola state). Wukari is located at latitude $7^0$51North and longitude $9^0$47 East. Wukari is situated at elevation 189 meters above sea level with a mean annual rain fall of 1300mm (Wikipedia, 2016). It mean annual maximum temperature varies from 30^0-39.4^0C The total land mark of Wukari is 4,308km^2 and a population of 241,546 as at 2006 census (World atlas, 2015). Wukari lies between of Taraba State and Benue State and it is an agricultural based center.

Experimental Materials

The experiment consisted of two sweet potatoes varieties, namely, white skin variety and red skin variety which were obtained from Wukari local government area. Other materials used for the experiment includes; cutlasses, hoes, pegs, ropes, meter rule, record book, pen, masking tape, nylon, 20kg weighing scale and jute bags.

Treatments and Experimental Design

The experimental treatments consisted of two sweet potato varieties and four different vine planting methods (direct, one ring, two ring, and three rings vine planting method) which were laid in a randomized complete block design (RCBD) with three replications. The plot size of 2mx2m is used while the total land used for the experiment was 25m x 15m with 1m and 2m spaces between plots and replicates respectively.

Land preparation and planting

The experimental land was cleared and ploughed manually using traditional hoes and cutlasses. Raised beds of 2m high were made manually to a size of 2mx2m plots per planting methods with an intra and inter row spacing of 1mx2m between plot and blocks respectively giving a total number of 24 beds as experimental plots. Young middle portion of about 30cm vine cuttings were planted with 2/3 of its lengths covered with soil to a depth of 2cm. One vine cutting was planted in each hole for the different planting methods on the raised beds. Supply was done to replace dead vines after one week of planting.

Weed Control

Manual hoe weeding of the experimental plot was done at two weeks after planting to keep the field free of weeds during the growth periods of the plants. Heartening of the plants was also done in other not to expose the storage roots.

Data Collection

Growth Parameters

The data for growth parameters were recorded from three randomly selected plants in each experimental plot which were properly tagged. The data recorded for the growth parameters included length of primary vine (cm), number of secondary vine, number of nodes, number of leaves, leaf area (leaf breath x leaf length) and canopy formation. The growth parameter data were collected and recorded at weeks 4,6,8,10,12 and 14 after planting

Yield and yield components

Yield data collection was recorded at harvest, when about 80-85% 0f the leaves turned yellowish in colour. The data recorded at harvest included; number of tubers per plant, weight of tubers (kg), length of tubers (cm) and width of tubers (cm).

Root fresh weight (kg/plant): Storage roots of plants in each net plot were dug out at harvest and weighed using a 20kg weighing scale.

Average number of storage roots: This was recorded by counting the actual number of storage roots harvested per plot and divided by the total number of plants counted at harvest.

Storage root length (cm): This was determined by measuring the length of matured storage roots of three randomly selected plants from each plot and the averaged recorded for statistical analysis.

Storage root width (cm): This was measured at the widest point at the middle portion of the selected plants of the matured storage root of the three randomly selected plants.

Statistical Analysis

The data recorded for both growth parameters and yield of tubers were subjected to analysis of variance (ANOVA) at 5% level of probability using statistical analysis software (SAS). Difference between treatments means were compared using the Least Significant Difference (LSD) and Duncan Multiple Range Test.

TABLES

Table 1: The soil chemical and physical properties analysis of the Teaching and Research Farm, Federal University, Wukari.

pH	6.54
Organic carbon (%)	1.06
Organic matter (%)	1.83
Total N (%)	0.13
Available P (MgL^{-1})	5.60
Exchangeable K (mol/kg)	0.28
Exchangeable Na (mol/kg)	0.25
Exchangeable Ca (mol/kg)	3.00
Exchangeable Mg (mol/kg)	2.40
Exchangeable Acidity (mol/kg)	1.10
TEB	6.13
CEC	7.23
Base Saturation (%)	84.80
Sand (g/kg)	76.80
Clay (g/kg)	13.20
Silt (g/kg)	10.00
Textural Class	Sandy-loam soil

Table 2: Effect of Sweet Potato Varieties on the growth parameters taken at various growth stages.

Variety	WAP	Length of primary vine	Number of secondary vine	Number of leaves	Number of Nodes	Leaf Area	Canopy Formation
White	4week	33.08 b	4.94 a	48.89 b	35.72b	79.64 b	2.00a
Pink		88.14 a	4.78 a	72.33 a	61.50a	102.78a	2.00a
LSD (5%)		10.63	1.76	12.99	10.43	8.48	0.41
White	6week	107.46b	27.22 a	103.25b	147.28 b	124.35a	2.00a
Pink		168.31a	19.72 b	206.53a	217.72 a	114.04a	2.00a
LSD (5%)		18.19	5.39	26.59	36.36	14.95	0.39
White	8week	183.07b	41.19 a	203.25 b	361.67 b	130.18a	2.00a
Pink		240.31a	21.61 b	266.53 a	446.56 a	108.68b	2.00a
LSD		22.46	9.63	46.59	67.69	12.33	0.41
White	10week	230.81a	46.28 a	640.94 a	548.44 a	153.92a	2.00a
Pink		257.03a	25.69 b	560.93 a	537.26 a	136.69a	2.00a
LSD (5%)		28.09	6.24	97.84	93.09	49.79	0.41
White	12week	312.33a	51.78 a	671.11a	548.44 a	163.74a	2.00a
Pink		282.33a	28.36 b	620.78a	537.26 a	117.18a	2.00a
LSD (5%)		118.71	6.31	89.58	93.10	67.67	0.42
White	14week	315.58a	53.33 a	572.86a	575.81 a	126.10a	2.03 a
Pink		290.81a	30.78 b	589.03a	623.22 a	114.24b	2.00a
LSD (5%)		29.32	6.07	86.35	93.88	10.42	0.41

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 3: Effect of Treatments on the Length of Primary Vine taken at different growth stages.

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	40.38 b	128.18a	198.33a	239.83 a	248.44a	296.06ab
OneRing Planting	53.94ab	140.41a	222.11a	256.94 a	279.72a	309.94ab
TwoRings Planting	65.02a	152.32a	222.25a	239.33 a	287.34a	331.56a
ThreeRing Planting	73.11a	134.64a	205.06a	239.56 a	373.82a	275.22b
LSD (5%)	19.87	33.99	41.99	52.49	221.84	54.79

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 4: Effect of Treatments on Number of Secondary Vine of Sweet Potatoes taken at different growth stages.

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	2.94c	16.44c	25.89b	29.89b	33.89b	35.94b
OneRing Planting	3.56b	19.00bc	27.00a	34.33ab	38.06ab	41.67ab
TwoRings Planting	6.72a	31.00a	41.28a	43.67a	47.50a	47.39a
ThreeRings Planting	6.22ab	27.44ab	31.94a	36.06ab	40.83ab	43.22ab
LSD (5%)	3.28	10.08	17.99	11.67	11.78	11.35

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 5: Effect of Treatment on the Number of Leaves Sweet Potatoes taken at different growth stages.

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	38.61b	165.28 b	390.78b	501.50b	530.28b	458.72b
OneRing Planting	47.67b	195.50 b	430.50b	565.94ab	597.94b	542.83b
TwoRing Planting	72.22a	291.06 a	563.11a	711. 64a	791.39a	728.17a
ThreeRing Planting	83.94a	287.72 a	506.39ab	624.67ab	664.17ab	594.06 ab
LSD (5%)	24.27	87.08	128.31	182.84	167.41	161.37

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 6: Effect of Treatment on the Number of Nodes Sweet Potatoes taken at different growth stages.

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	32.44c	129.06 b	318.33b	437.94b	454.37b	513.72b
OneRing Planting	38.06bc	147.17b	374.56b	510.28ab	472.28b	558.11ab
TwoRing Planting	55.44ab	231.22a	501.61a	650.24a	729.50a	694.44a
ThreeRing Planting	68.50a	222.56a	421.94ab	572.94ab	607.78ab	631.78ab
LSD (5%)	19.48	67.95	126.51	173.98	177.61	175.45

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting,

Table 7: Effect of Treatments on the Leaf Area of sweet potatoes taken at different growth stages

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	74.63 b	100.29 b	113.96 a	171.38 a	121.36 a	118.68 a
OneRing Planting	87.53 ab	125.11 ab	129.30 a	143.74 a	188.92 a	126.79 a
TwoRing Planting	102.05 a	131.32 a	118.27 a	135.39 a	126.93 a	114.64 a
ThreeRing Planting	100.65 a	120.05 ab	118.21 a	130.71 a	124.65 a	120.57 a
LSD (5%)	15.86	27.95	23.04	93.05	126.46	19.47

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 8: Effect of Treatments on the Canopy Formation of Sweet Potatoes taken at different growth stages

TREATMENT	4th week	6th week	8th week	10th week	12th week	14th week
Direct Planting	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a
OneRing Planting	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a
TwoRing Planting	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a
ThreeRing Planting	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a	2.00 a
LSD (5%)	0.77	0.73	0.77	0.77	0.78	0.77

Values with different letters along the columns are significantly different using DMRT at 5% probability level. WAP = Weeks after planting.

Table 9: Effect of Sweet Potatoes Variety on Yield Parameters taken at Harvest.

VARIETY	Number of Tuber	Weight of Tuber	Length of Tuber	Width of Tuber
White	5.89 b	2.76 a	22.01 a	38.15 a
Pink	8.47 a	1.88 b	20.29 a	26.71 b
S.E	0.67	0.13	1.22	1.73
LSD (5%)	1.34	0.63	2.43	3.45

Values with different letters along the columns are significantly different using DMRT at 5% probability level.

Table 10: Effect of Treatments on Yield Parameters of Harvested Sweet Potatoes.

TREATMENT	Number of Tuber	Weight of Tuber	Length of Tuber	Width of Tuber
Direct Planting	5.33b	1.77b	18.64b	31.86a
OneRing Planting	7.00ab	2.28ab	24.01 a	32.02a
TwoRing Planting	8.28a	2.70a	20.73ab	32.56a
ThreeRing Planting	8.11a	2.53a	21.22ab	33.28a
LSD (5%)	2.49	1.17	4.55	6.45

Values with different letters along the columns are significantly different using DMRT at 5% probability level.

Table 11: Effect of Variety and Treatments on Yield Parameters of Harvested Sweet Potatoes.

VARIETY	TREATMENT	Number of Tuber	Weight of Tuber	Length of Tuber	Width of Tuber
White	Direct Planting	3.55 b	1.92ab	20.64ab	38.51a
	OneRing Planting	5.78ab	2.62ab	23.72ab	38.65 a
	TwoRings planting	7.33ab	3.76 a	22.68ab	40.21 a
	ThreeRings Planting	6.89ab	2.72ab	20.99ab	35.21ab
Pink	Direct Planting	7.11ab	1.62 b	16.64 b	25.21 b
	OneRing Planting	8.22a	1.93 ab	24.29 a	25.38 b
	TwoRings planting	9.22a	1.64 b	18.78ab	24.91 b
	ThreeRings Planting	9.33a	2.33ab	21.44ab	31.36b
LSD (5%)		4.19	1.96	7.63	10.82

Values with different letters along the columns are significantly different using DMRT at 5% probability level.

RESULTS

Soil analysis was conducted during the research and the above results were obtained. The textural class of the soil is sandy loam soil, with a pH of 5.75, and cation exchange capacity of 10.4 (CEC), total exchangeable base of 9.3 (TEB) and other characteristics of the soil as seen above (table 1). The effect of varieties on the length of primary vines of sweet potato is shows Table 2. White variety had the highest significant length of primary vine than the pink variety at 4, 6 and 8 weeks after planting moreover at 10, 12 and 14 weeks, no significant difference was observed between the two cultivars. Although, the pink variety had a higher mean value than the white variety at 10 weeks after planting, but at weeks 12 and 14, weeks white variety gave the highest mean values. There were significant differences on the number of secondary vines between white and pink variety at all weeks measured except at 4 week. The results indicated that white variety having a higher means values than the pink variety. The number of leaves recorded also revealed that pink variety produced the highest significant leaves number than white variety at 4 6, and 8 weeks while there was no significant difference observed on the effect of variety on the number of leaves at others weeks sampled. Varietal effect on number of nodes at weeks 4, 6 and 8 weeks revealed that pink variety produced the highest number of nodes but showed no significant difference at weeks 10, 12 and 14 weeks after planting even though the pink variety gave higher mean values than the white variety. Varietal effect was significant on the leaf area of the crop at 4, 8 and 14 weeks after planting. At 4 weeks pink variety gave the highest significant leave area but at 8 and 14 weeks it was white variety that gave the highest significant values. Variety had no significant effect on the canopy formation of the crop throughout the sampling period.

The response of treatments on the length of primary vines is shown (table 3).It was observed that three and two ring vine pattern produced the significantly longer length of primary vine at week 4 followed by one ring vine pattern planting while direct vine planting having the least significant value. Furthermore, the results recorded showed that there were no significant differences in the treatments used on the length of the primary vine at 6, 8 10 and 12 weeks after planting moreover at 14 weeks two rings planting pattern gave the highest significant length of primary vine followed by one ring planting pattern and direct planting while three rings planting pattern showing the least significant length of sweet potato primary vines.

The vine planting pattern used in the study had a significant effect on the number of secondary vines taken at all the sampling periods as shown (table 4). At 4 weeks two rings plant gave the highest significant secondary vine number (6.72) which was followed by three rings planting (6.22) while direct planting gave the least value of (2.94).

At 6 week, two rings planting also produced the highest significant secondary vine number which was statistically similar to three rings planting followed by one ring planting with the least value coming from the direct planting treatment. There's no significant differences between the one ring, two ring, and three ring plants at 8 weeks after planting but they are significantly better than the direct planting treatment. At 10, 12 and 14 weeks after planting the number of secondary vine of sweet potato recorded follow a similar trend where two ring plants produced the highest significant values for secondary vine number followed by the three rings and two rings treatments while the least value was from the direct planting.

Table 5 showed the effect of treatments on the number of leaves of sweet potato at all the growth period taken. The results revealed that there was a significant effect across the growing period measured. At 4 and 6 week after planting, it was observed that three and two ring plants produced the highest significant leaves number which was followed by one ring which was statistically similar to direct planting values recorded. At 8,10, 12 and 14 weeks after planting, two rings planting had the highest significant number of leaves and were statistically similar to three rings planting while one ring planting and direct planting having the least significant leaves numbers even though one ring planting gave a higher mean value than the direct planting method.

The effect of treatments on the number of nodes throughout the growth period of the crop is shown in table 6. Three rings planting gave the highest number of nodes at 4 week which was statistically similar to two ring treatment moreover followed by one ring planting while direct planting having the least nodes number. At 6 weeks, two and three rings planting had the highest significant values for nodes number and followed by one ring and direct planting which are statistically similar. At 8, 10, 12 and 14 weeks after planting, two rings planting gave the highest significant values for nodes number although were statistically similar to three rings planting as well as one ring planting only at 10 and 14 weeks while Direct planting gave the least number of nodes and was similar to one ring planting at 8 and 14 weeks of the growth periods.

Treatments significantly influenced the leave area of the crop plant only at 4 and 6 weeks after planting while there was no significant effect at all other growing period measured (table 7). At 4 weeks two and three rings gave the significantly higher leave area follow by one ring while the direct planting gave the least value. Furthermore at 6 weeks two ring plant was observed to produce the significantly higher leave area which was similar to both three and one ring planting of course the least value was recorded for direct planting.

The results of the canopy formation of the crop plant (table 8) indicated that there were no significant differences among the treatments used in all the growing period measured in the study.

The results in table 9 showed the effect of sweet potato variety on the yield parameters taken at harvest. The number of tubers was significantly higher in pink variety (8.47) than the white variety (5.89). The white variety produced the best weight of the tuber in the study (2.76kg) more than the pink variety (1.88kg) while there was no significant difference in the length of tuber formed between the varieties used in the study. The width of the tuber was at the best significantly with the white variety than the pink.

Table 10 showed the effect of treatments on the yield of harvested sweet potato tubers. The results indicated that two rings and three rings planting methods gave the highest number of tubers which were statistically similar to one ring planting, while direct planting method gave least number of tubers. The same trend was observed with the respect to the weight of tuber where two and three rings planting gave the significantly higher tuber weights followed by one ring and the least weight was recorded for the direct planting treatment. One ring planting produced the longest tuber followed by the two and three ring planting while the direct planting gave the least length. Lastly there was no significant difference in the width of the tuber produced among the treatments used.

The effect of variety and treatments in the study is shown in table 11. There were significant differences on sweet potato tuber yield parameters taken and with the respect to the number of tubers, pink variety when planted using one ring, two rings and three rings gave the highest significant number of tubers followed by pink variety and the direct planting method, one, two and three rings planting methods with the white variety, which were all similar statistically. The least number of tubers was from the combination of white variety using direct planting. The best weight of tuber was recorded for white variety when using two ring planting method while for the length of tuber the pink variety and one ring planting method was the best and was significantly different from other treatments combinations. The interactions between the white variety, two and one ring planting as well as the direct planting produced the best width of tuber and these are better than any other interactions in the study.

DISCUSSION

The results obtained from the growth parameters of sweet potato varieties in the study indicated that pink variety recorded longer vine length, higher number of leaves and nodes and leaves area than the white variety. Furthermore, the number of secondary vine was higher and better in white variety than the pink. This may be due to the inherent genetic ability in pink variety which gave genetic superiority over the white as documented by Amarullah (2020) and Adetunji et al, 2011 on Cassava crops. The longer and many vines produced can also be advantages to be used as forage for ruminants feeding due to their richness in proteins and minerals needed in livestock feeds (Ahmed et al., 2012; Gonzales et al., 2003). Furthermore, the longer the vine of sweet potato, the more the leaves that will be formed and subsequently available to sunlight for higher photosynthesis processes. This is also supported by the work of Enyi, (2004) that increasing branch production resulted in the production of more leaves. The result of the research after harvest showed that there were significant effect and difference in the number of tubers, weight of tubers and width of tubers with respect to variety. But no significant difference was observed for the length of tubers as both varieties showed similar effect. The white variety produced the highest yield parameters after harvest except for the number of tuber which the pink variety was highest. The differences in tuber yield parameters could be attributed to genetic variations among genotypes in partitioning photosynthates. Differences in yield parameters due to the genetic makeup among genotypes have also been reported in other sweet potato trials (Chipungu et al., 1999, Nedunchezhiyan et al., 2007) as well as other crops such as common beans (*Phaseolus vulgaris*) Mwale et al., (2008), Mwale et al., (2009) and Chataika et. al., (2010).

The response of the crop to different methods of vine planting pattern showed that two rings planting pattern gave the highest response in all the growth parameters taken of vine followed by the three rings planting and the one ring planting pattern while the direct planting recorded the lowest. This may be as results of new innovation of using a ring or two rings style of vine planting pattern which increase the number of nodes buried between 5 to 12 into the soil and eventually improved the growth parameters of sweet potato. The canopy coverage produced by the ring pattern of planting was profuse, shading the soil surface from sunshine thereby reducing the rate of weed growth within the sweet potato plots. Thus, saves the farmer some cost of weeding. This is in line with the finding of the following workers (Moyo et al., 2004 and Workayehu et al., 2011).

In this study, number of tuber, tuber weight and length of tuber were all affected by the ring planting pattern but the width of tuber indicated no significant difference. The two rings, three ring and one ring treatments are better when compared to the direct vine planting which shows that methods of planting play an important role in many morphological and physiological processes that occurs within the sweet potato which translates into the kind of yield result obtained. The ring style of vine planting is one of the new ways of increasing the tuber yield of sweet potato. The ring styles of planting provide nodes of 5 to 12 instead of 2 to 3 nodes from traditional direct plant method which resulted into more number of tubers per plant. The interaction between variety and vine planting methods on yield parameters also showed that the ring planting methods when used on varieties produced better number of tuber, weight of tuber, length and width of tuber than the direct vine planting method.

The result also indicated that two rings and three rings planting exert strong influence on sweet potato tuber growth, development and yield.

CONCLUSION

The new innovation of ring vine planting patterns especially two and three ring methods are more highly profitable broad-scale tuber crop ideally suited for increase productivity and grower confidence in the crop than the direct planting method which is a traditional method which needs to be transformed. Therefore, there is a need train more farmers to adopt this new vine pattern of planting for increase productivity of the crop and this could be achieved through organizing local farmers training through Agriculture Development Projects (ADP) and Small Plot Adoption Technique (SPAT), advert on television on radio and more researches of such in different locations.

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