



Original Research Article

Effect of Pumpkin (*Cucurbita pepo*) Sowing Density on Weed Dynamic and Water Yam (*Dioscorea alata*) Yield in Southeastern Nigeria

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ABSTRACT

A field study was carried out in Uyo, Southeastern Nigeria in 2011 and 2012 to compare the potential of using pumpkin intercrop as a means of cost effective weed management in water yam (*Dioscorea alata*) farm. The experiment was laid out in a randomized complete block design. The treatments were included no weeding, weeded (3x), chemical weeding (Raft 500) + supplemented hoe weeding at 12 weeks after planting (WAP), Dynamic population densities of 10,000, 20,000, 30,000 and 40,000 supplemented with one hoe weeding at 4 WAP. The result of the study showed that weeded 3x treatment performed better in all the growth and yield parameters assessed but not significantly ($P < 0.05$) above the growth and yield values obtained from 30,000 population density of pumpkin. The weeded (3x) resulted to tuber yield of 22.81 and 20.75 t.ha⁻¹ in 2011 and 2012 respectively, while, the 30,000 pumpkin population density had tuber yield of 19.81 and 19.35 t.ha⁻¹ in 2011 and 2012 respectively. The least tuber yields 3.22 and 2.18 t.ha⁻¹ was obtained from no weeding treatment. The weeded (3x) treatment had 9-86 and 8-90 percentage tuber yield above other treatments but 13 and 8% over 30,000 pumpkin population density alone. The study suggests that pumpkin intercrop at 30,000 stands per hectare could effectively reduce weed interference in water yam farm.

Introduction

Yam is a very important crop in West African, especially in Nigeria. The region alone produces more than 90% of world production of yam (Etokeren, 2016). Nigeria is currently the largest producer of yam in the world (FAO, 2015). Most of the yam grow in Nigeria are from smallholder

farmland. Yam production is labour intensive and weeding alone is about 30 percent of the labour requirement for yam production in Nigeria. Yam lacks the ability to develop full canopy cover and is therefore susceptible to weed competition for a longer period of its growth cycle than most food crops (Akobundu, 1987). Yam demand for frequent weeding is exceeded only by upland rice. Yam has a long growing season of 7-9 months depending on cultivar and time of planting. The inability of yam to shade the ground completely at any stage of its growth and development makes it susceptible to weed interference (Akobundu, 1987). In humid and tropical environment where rainfall, humidity and other favorable growth factors are available in abundance, weeds grow fast and become well established before the initial slow growing tuberous crop established. Weeds which emerge during the first three months after planting are known to endanger yields more than those appearing later (Iyagba, 2010).

Farmers in Nigeria apply different methods of weed management and control in yam production. The new technology on yam minisetts for larger scale yam production has led to an increase in the use of herbicides. In some parts of the world, the use of herbicides in weed control is still the cheapest means of combating weeds. Many small scale farmers in Nigeria, seldom use herbicides in controlling the weed menace in their farms due to numerous problems. These problems are the cost of herbicides, which are too expensive for the resource poor peasant farmers. Living mulches were shown to provide many benefits for an agricultural system by conserving soil moisture, recycling soil nutrients, improving soil physical properties, suppressing weed growth and field pests (Schulz and Marocco, 2012). Cover crops provide a physical barrier to pests, their debris produce high plant residues by increasing organic matter content of the soil, protect soil surface which can influence weed germination and growth during the raining season and it reduces sun light penetration. Cover crops modify the microclimate of the agricultural system. Some cover crops release allelochemicals (Teasdale and Mohler, 1993; Teasdale and Abdul-Bak, 1998; Ikeh et al. 2017; Ikeh, 2017). The integration of living mulches in yam is necessary due to the low competitiveness and slow development of yam. Inter specific competition for natural resources with quantitative and qualitative yield losses may occur in this system if weed growth is not appropriately managed. According to Dominic (2018), living mulches suppressed weeds by up to 71% and led to herbicide reductions of 65% in combination with prior hoeing and band-spraying compared to overall boom spraying. The cultivation of living mulches 30 days after sugar beet sowing resulted in insignificant changes of white sugar yield and qualitative parameters compared to the overall boom spraying. An optimum cover crop population per hectare is also required to be studied in order to minimize inter and intra specific competition between cover crops and component crops. The

acceptance of this cultivation method would substantially reduce number of hoe weeding from 2-3 times to one, reduce herbicide inputs in the long term and also improved sustainable production of yam in Nigeria. Also the use of low growing crops as life mulch is a major weed management and control in the farming system of the southeastern Nigeria. The low growing crops suppress weeds; light and space will be taken by cover crops which help in covering the soil and reducing the opportunity of weed to be established (Kolo et al. 2004). Low growing crops such as egusi melon, cowpea and groundnut are an efficient means of conserving soil moisture and increasing leaf water status and crop yields (Ikeorgu and Igwilo, 2002), as well as increasing revenue and organic matter content (Ikeh et al. 2012). There is paucity of information in the available literature on the use of pumpkin (*Cucurbita pepo*) on weeds control in water yam farm. Udoh and Ndon (2016) noted that intercropping root and tuber crops with low growing crops are quite common practices in southeastern Nigeria.

Despite the significance of cover crops as life mulch, most of the farmers are still confusing on actual population density that will smother the weeds and invariably encourage high yield of the base crop. Therefore, this study was undertaken to assess the response of water yam (*Dioscorea alata*) to different plant population of pumpkin as weed suppressant.

Materials and Methods

The study was conducted during the early cropping season of 2011 and 2012 at the National Cereals Research Institute, Uyo Out station. Uyo is located in the lowland humid tropic about 65 meters above sea level (UCCDA 1989). The area is situated between latitude 5.17° and 5.27°N and longitude 7.27° and 7.58°E. The climate of the area is humid tropical and is characterized by rainfall and relatively short dry season. The rainfall pattern is bimodal in nature. The rainy season usually begins in mid-March and ends in mid-November with a short dry spell of uncertain length in August. The dry season begins in mid-November and ends in mid-March. The annual mean rainfall of the area is 2500 mm/annum while the annual mean temperature varies between 25°C and 27°C, respectively. The relative humidity of the area ranges from 60-90% while the mean monthly sunshine hours during the rainy season is 3 hours 3 minutes and that of the dry season ranges between 8 to 10 hours. The soils of Uyo are formed on plain sands and are acid sands with low cation exchange capacity (CEC) and usually suffer from multiple nutrient deficiencies (Enwezor et al. 1990). The experimental site used had been under continuous cropping for the past 20 years to various arable crops such as, rice, sugar cane, cassava, maize, cowpea and fluted pumpkin in the field experiment site of National Cereals Research Institute Uyo-out Station. The plot used for the

study was in fallow a year before this trial was conducted. The results of the experimental soil regarding soil pH, organic matter content nitrogen content was 5.30, 2.01% and 0.09 %, respectively. The exchangeable bases were; Ca (2.11 cmol/kg), Mg (1.15 cmol/kg), K (1.01 cmol/kg) and Na (0.54 cmol/kg). The particle size distribution indicated that the soil of the experimental soil was sandy loam with sand particle of 87.50%, silt (4.60%) and clay (7.90%). The experiment was laid out in a randomized complete block design (RCBD) replicated three times. The experimental treatments were: no weeding, weeded 3x (hoe weeding), pre-emergence herbicide -Raft 500 SC (Atrazine and metolachor at 3.0 kg ai/ha), pumpkin at densities of 10,000, 20,000, 30,000 and 40,000 plants per hectare which is the ranges farmers in southeastern preferred planting pumpkin in mixed stands with root and tuber crops. All the pumpkin sowing densities were supplemented with one hoe weeding at 5 weeks after planting (WAP) which is fall within the critical period in yam. Land preparation was manually done with aid of machetes and spade during the month of March in both cropping seasons. The plot cleared was left to dry for five days, then the trashes and debris were raked and packed at the borders. Ridges of 8 m long were constructed with spade and Indian hoe at a spacing of 1 m x1 m. The 180 g of yam cultivar known as Abere (local adaptable cultivar in Akwa Ibom and other southeastern farming system of Nigeria) was obtained from the traditional barn of National Root Crop Research Institute (NRCRI)Umudike, Umuahia, Abia State. The ware seed tubers were planted on the crest of 8 m x 8 m ridges while cover crops (pumpkin) was planted at 2/3 of ridges at different populations base on treatment basis. The herbicides (Raft 500 SC) were applied a day after the crop has been planted, with the aid of Knapsack sprayer, at recommended rate of 3.0 kg ai/ha (Udoh and Ndon, 2016). Manual weeding was done at 4 and 9 WAP followed by slashing at 5 months after planting (MAP) on 3x weeding treatment. No weeding was done on unweeded plot. The following growth and yield parameters were assessed on water yam; vine length, number of leaves per plant, leaf area, number of tuber per stand, length/circumference of tubers and yield were assessed. Weed density and biomass were assessed in each plot. All data collected were subjected to analysis of variance. The significant means were separated with Duncan multiple range test.

Results and Discussion

Weed density and biomass as influenced by pumpkin sowing densities is presented in Table 1. The result indicated significant differences on weed densities from different plots were compared. Among the weed management treatments, the highest weed density (81.75 and 213.42 in 2011) and (101.25 and 226.20 in 2012) at 2 and 4 month after planting (MAP) was recorded in the treatment of no weeding. Comparing the other weed management methods, the treatments of hoe

weeding and chemical weeding treatments reduced weed growth effectively at 2 MAP, irrespective of cropping season (Table 1). At 4 MAP, the result showed significant reduction in weed population per area with increase in pumpkin population per hectare. The 40,000 pumpkin populations had weed density of 5.25 and 22.33 at 4 MAP in 2011 and 2012 cropping seasons, respectively. At 4 MAP, the use of 40,000 pumpkin populations per hectare reduced weed growth 84-98% and 83-90% in 2011 and 2012 compared to the other treatments.

Table 1. Weed Density influenced by different weed management.

Treatment	2011		2012	
	Months After Planting		Month After Planting	
	2	4	2	4
No weeding	81.75a	213.42a	101.25a	226.20a
Weeded (3x)	3.30e	20.11c	8.66de	29.22c
Chemical control	10.01d	25.06c	12.18d	39.04b
10,000 p/p*	40.66b	34.15b	38.01b	45.70b
20,000 p/p	25.70c	20.16c	23.37c	31.07bc
30,000 p/p	16.25d	6.17d	11.30d	24.25c
40,000 p/p	11.11d	5.25d	5.60e	02.33c

The mean values with the same superscript are not significantly different at $p < 0.05$. *p/p =Pumpkin population.

Weed biomass as affected by pumpkin population per hectare is shown in Table 2. The weed biomass recorded maintain similar trend as in weed density. The result indicated significant differences among the treatments on weed biomass. The largest weed biomass (182.40g and 349.38 g in 2011) and (220.59 g and 363.81 g in 2012) was recorded in no weeding treatment. The treatment of 10,000 pumpkin populations per hectare plot had weed biomass of 81.51g and 101.59 g at 2 and 4 MAP in 2011. In 2012, 59.44g and 86.75g biomass was recorded. At 4 MAP, the least weed biomass per unit area; 30.70 g and 38.69 g in 2011 and 2012 cropping seasons, was from the treatment of 40,000 pumpkin populations per hectare. The weed management of 40,000 pumpkin population reduced weed biomass between 71-91% and 72-89% in both cropping seasons, compared to the other weed management methods. The effect of different weed management techniques on water yam vine length differed significantly ($P < 0.05$) in both cropping seasons (Table 3). The plot weeded 3 times had the longest vine; 78.40, 155.13, 203.41 and 251.11 cm in 2011 and 81.30, 166.11, 218.41 and 266.30 cm in 2012 at 2, 3, 4 and 5 months after planting (MAP) respectively (Table 3).

Table 2. Weed Biomass as influenced by different weed management.

Treatment	2011		2012		
	Months After Planting		Month After Planting		
	2	4	2	4	
No weeding	182.40 ^a	349.38 ^a	220.59 ^a	363.81 ^a	1
Weeded (3x)	36.39 ^d	70.43 ^c	58.73 ^c	62.40 ^{cd}	3/4
Chemical control	25.40 ^f	88.22 ^c	37.50 ^d	79.70 ^c	3
10,000 p/p	81.51 ^b	101.59 ^b	59.44 ^c	86.75 ^c	3
20,000 p/p	42.30 ^c	72.63 ^c	35.60 ^d	101.33 ^b	2
30,000 p/p	30.09 ^e	49.81 ^d	22.47 ^e	61.14 ^d	4
40,000 p/p	41.13 ^c	30.70 ^e	70.68 ^b	38.69 ^e	5

The mean values with the same superscript are not significantly different at $p < 0.05$.

This was followed by chemical weed control method. The result also indicated no significant difference between the means values of vine length in hoe weeded (3x) and pumpkin population density of 30,000 plant/ha in both cropping season. The shortest vine on average was recorded from no weeding treatment, 48.11, 99.25, 118.25 and 135.13 cm in 2011, 55.31, 85.62, 129.33 and 150.38 cm in 2012 at 2, 3, 4 and 5 MAP respectively. The result further indicated decrease in vine length at 40,000 pumpkin populations per hectare in both cropping season (Table 3). Table 4 shows the effect of pumpkin population per hectare on number of water yam leaves per plant. The result showed significant difference ($P < 0.05$) with hoe weeding (3x) treatment producing significant number of leaves on average (108.30, 136.33 and 147.40 in 2011, 27.60, 112.30, 133.60 and 142.12 in 2012 at 3, 4 and 5 MAP respectively) compared no weeding, 10,000 and 40,000 pumpkin population treatments. In all the months under study, there was no significant difference in number of leaves per plant when the treatment 30,000 pumpkin population was compared to hoe weeding, chemical weed control. Although significant difference ($p < 0.05$) was observed when compared with 10,000 and 20,000 pumpkin population. The leaf area of water yam as influenced by pumpkin population also varied significantly ($P < 0.05$) (Table 5). Hoe weeding (3x) plot had the largest leaf area; 23.81, 25.14, 30.60 and 31 cm² at 2, 3, 4 and 5 MAP in 2011 while the following corresponding leaf area, 21.80, 26.11, 31.27 and 31.80 cm² was recorded in 2012. This was followed by chemical weeding; 20.71, 25.01, 27.38 cm² in 2011. In 2012, following leaf area was recorded in the plot of chemical weeding; 20.92, 26.80, 28.77 and 28.93 cm² at 2, 3, 4 and 5 MAP respectively. The least leaf (12.44, 13.38, 15.30 and 17.16 cm² in 2011) and (11.51, 11.93, 13.66 and 15.81 cm² in 2012) was recorded from the treatment of no weeding treatment. The result also

showed no significant difference between hoe weeding (3x) and 40,000 pumpkin population except at 3 MAP in 2012 trial. The results of yield and yield component as influenced by pumpkin sowing densities also maintain the similar pattern as in vegetative parameters (Table 5). The hoe weeded (3x) plot, produced significant higher number of tubers per plant, 4.33 and 4.93 in 2011 and 2012, respectively.

Table 3. Water yam vine length as influenced by different weed management.

Treatment	2011				2012			
	Months After Planting				Month After Planting			
	2	3	4	5	2	3	4	5
Weeding	48.11 ^c	99.25 ^c	118.25 ^c	135.13 ^d	55.31 ^c	85.62 ^c	121.33 ^c	150.38 ^d
Weeded (3x)	78.40 ^a	155.13 ^a	203.41 ^a	251.11 ^a	81.30 ^a	166.11 ^a	218.41 ^a	266.30 ^a
Chemical control	78.83 ^d	143.14 ^a	197.52 ^a	222.13 ^a	78.13 ^{ab}	153.14 ^a	185.30 ^b	241.81 ^a
10,000 p/p	69.40 ^{ab}	131.38 ^b	173.40 ^{ab}	201.41 ^b	72.40 ^b	142.18 ^a	180.11 ^b	211.80 ^b
20,000 p/p	73.12 ^{ab}	147.13 ^a	184.12 ^a	217.30 ^{ab}	76.30 ^{ab}	148.16 ^a	179.20 ^b	218.30 ^b
30,000 p/p	78.36 ^a	153.16 ^a	198.62 ^a	234.62 ^a	77.40 ^{ab}	157.18 ^a	203.25 ^a	233.40 ^a
40,000 p/p	68.43 ^b	130.67 ^b	166.91 ^b	194.62 ^c	72.52 ^b	125.69 ^b	183.40 ^b	205.11 ^c

The mean values with the same superscript are not significantly different at $p < 0.05$.

This was followed by chemical weeded plot; 3.75 and 3.89 in 2011 and 2012 respectively. The result showed no significant difference between hoe weeded plot, chemical weeded plot, 20,000 and 30,000 pumpkin population per hectare treatments in both cropping seasons. The hoe weeded (3x) treatment had 13-76% and 21-76% more number tubers per plant compared to the other treatments but only 18 and 24% when compared to 30,000 pumpkin population plot alone. The lowest number of tubers per plant, 1.02 and 1.18 was obtained from no weeding plot. The result showed significant difference in tuber length and circumference. The weeded (3x) plots had significant longer tuber and bigger tuber circumference, in both cropping seasons respectively. The shortest tuber and the smallest tuber circumference were recorded from control (no weeding).

The result of tuber yield in tonnes per hectare showed that hoe weeded plot had the significant tuber yield, 22.81 and 22.75 t.ha⁻¹ in 2011 and 2012 respectively. The tuber yield of 21.68 and 20.47 t.ha⁻¹ was recorded in the plot treated herbicide. The treatment of 30,000 pumpkin populations produced 20.68 and 20.35 t.ha⁻¹ in both cropping seasons. The least yield, 3.22 and 2.18 t.ha⁻¹ was obtained from no weeding treatment. The result indicated reduction in tuber yield at 40,000 pumpkin populations, 13.28 and 14.15 t.ha⁻¹ in 2011 and 2012 respectively. The hoe weeded plot (3x) had tuber yield of 5-86 and 10-91% more than the other treatments in 2011 and

2012 respectively. When hoe weeded plot was compared to 30,000 pumpkin population, the difference in tuber yield was 9 and 11% in both cropping seasons.

Table 4. Number of water yam leaves as influence by different weed management.

Treatments	2011				2012			
	Months After Planting				Month After Planting			
	2	3	4	5	2	3	4	5
None weeded	19.33 ^b	23.14 ^c	29.75 ^c	33.60 ^d	8.41 ^b	21.31 ^c	30.60 ^d	39.36 ^c
Weeded (3x)	28.78 ^a	108.30 ^a	136.33 ^a	147.40 ^a	27.60 ^a	112.30 ^a	133.60 ^a	142.12 ^a
Chemical control	27.69 ^a	99.36 ^a	125.60 ^a	138.40 ^a	26.18 ^a	108.60 ^a	124.77 ^{ab}	131.43 ^a
10,000 p/p	26.33 ^a	87.60 ^b	109.60 ^b	124.62 ^b	21.19 ^a	91.38 ^b	116.17 ^c	128.20 ^b
20,000 p/p	26.75 ^a	93.60 ^a	113.18 ^b	130.60 ^{ab}	22.13 ^a	100.60 ^a	118.62 ^c	130.60 ^{ab}
30,000 p/p	27.60 ^a	98.51 ^a	126.60 ^a	136.89 ^a	25.30 ^a	105.11 ^a	127.18 ^{ab}	136.20 ^a
40,000 p/p	26.50 ^a	89.69 ^{ab}	102.11 ^b	118.30 ^c	21.18 ^a	90.27 ^b	108.73 ^c	121.60 ^b

The mean values with the same superscript are not significantly different at $p < 0.05$.

The results of the study showed significant differences ($P < 0.05$) in both vegetative and yield parameters considered. The hoe weeded plot performed best in all the parameters assessed, followed by chemical weeding and 30,000 population density of pumpkin. The ability of pumpkin densities to increase the growth and yield of water yam could be due to its high number of leaves and wide coverage of ground thereby serving as life mulch in the yam field.

Table 5. Yield and Yield components influenced by different weed management.

Treatments	2011				2012			
	Number	Length	Circumfer	Tuber	Number	Length of	Circumfer	Tuber
	of tuber per plant	of tuber	ence of tuber	yield (t/ha)	of tuber per plant	tuber	ence of tuber	yield (t/ha)
None weeded	1.02 ^d	8.33 ^d	11.28 ^c	3.22 ^e	1.18 ^d	9.04 ^c	10.62 ^d	2.18 ^d
Weeded (3x)	4.33 ^a	20.14 ^a	28.43 ^a	22.81 ^a	4.93 ^a	19.38 ^a	25.16 ^a	22.75 ^a
Chemical control	3.75 ^{ab}	17.80 ^b	28.12 ^a	21.68 ^{ab}	3.89 ^{ab}	18.30 ^a	23.31 ^{ab}	20.47 ^{ab}
10,000 p/p	2.81 ^c	15.24 ^c	20.60 ^b	13.85 ^d	2.33 ^b	15.17 ^b	19.30 ^c	14.30 ^c
20,000 p/p	3.25 ^b	16.24 ^{bc}	26.33 ^a	17.60 ^c	3.36 ^b	16.08 ^{ab}	20.33 ^{bc}	19.70 ^b
30,000 p/p	3.55 ^b	17.84 ^b	27.80 ^a	20.68 ^b	3.77 ^{ab}	17.43 ^a	22.30 ^b	20.35 ^{ab}
40,000 p/p	2.14 ^c	15.18 ^c	19.93 ^b	13.28 ^d	2.39 ^c	14.98 ^b	18.44 ^c	14.15 ^c

The mean values with the same superscript are not significantly different at $p < 0.05$.

The observation agreed with the report of Akpan and Akata. (2016) that increase in cassava root yield when cowpea was intercropped with cassava which in turn suppressed weeds. The reduction in both growth and yield of water yam at 40,000 pumpkin population densities could be due to competition for nutrients and water, exist between both crops at higher density. Also, poor performance recorded in the treatment of 10,000 plant population could be that 10,000 plant population was not effective in suppressing weed growth compared to 30,000 population density. The lesser growth and yield performance observed in the treatment of 40,000 pumpkin population per hectare when compared with 30,000 pumpkin population could be due to higher inter plant competition between the both component crops. These findings agreed with Ikeh et al. (2017) that optimum higher density of cowpea and groundnut could economically reduce weed interference in yam farm. Akpan and Akata (2016) also reported that cover crops could reduce weed growth and sometime serve as competitor the base crop. of intercropping population reduced crop yield. The report of Akpan and Akata (2016) indicated that cowpea enhanced yield of yam while fluted pumpkin intercrop reduces the tuber yield.

Conclusion

Yam is an important tuber crop in Nigeria. Its production is labour intensive in Nigeria. Weed control in yam is time consuming and expensive. Therefore, this study has revealed that water yam could be planted with 30,000 stands of pumpkin per hectare for effective weed management. The adoption of 30,000 stands of pumpkin per hectare in water yam field could also help to save time and money especially during time of peak labour demand for other crops.

Conflict of Interest

Authors declare no conflict of interest.

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