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EFFECTS OF CROP SPACING AND WEEDING REGIMES ON THE GROWTH AND YIELD OF *Dioscorea alata* AND *Dioscorea rotundata* IN UYO, NIGERIA

***Sarah A. Bruno, Godwin N. Udom and Demben M. Esang**
Department of Crop Science, Faculty of Agriculture, University of Uyo, Uyo, Nigeria.
Corresponding author email:* **sarahakpan1986@gmail.com

Abstract
Experiments were conducted at Afaha Ikot Obio Nkan, Ibesikpo Asutan LGA, Akwa Ibom State, during the 2019 and 2020 cropping seasons to evaluate the effects of crop spacing and weeding regimes on yam minisett production. The experiment was arranged in a split-split plot design with three replications. White yam (*Dioscorea rotundata*) and water yam (*Dioscorea alata*) served as the main plot treatments. Crop spacings of 75 cm × 75 cm, 50 cm × 75 cm, and 50 cm × 100 cm were assigned to subplots, while weeding at 4 and 10, 6 and 12 weeks after planting and un-weeded control constituted the sub-subplot treatments. Data collected on weed density, yam minisett growth, and fresh tuber yield were analyzed using analysis of variance, and means compared using the least significant difference test at 5% probability level. Results showed that yam cultivars significantly ($p \leq 0.05$) influenced growth and fresh tuber yield. Water yam produced higher fresh tuber yields than white yam. 50 cm × 75 cm spacing recorded the highest tuber yield among the spacing treatments. Early weeding at 4 and 10 WAP significantly increased fresh tuber yield compared with weeding at 6 and 12 WAP, while un-weeded plots produced the lowest yield. Significant interaction between spacing and weeding regime showed that the highest fresh tuber yields (18.62 and 19.27 t ha^{-1}) were obtained from yam minisetts spaced at 50 cm × 75 cm and weeded at 4 and 10 WAP in both years. These practices are recommended for maximizing yam minisett yield in Uyo.

Keywords: Yam minisett, weeding regimes, crop spacing, interaction, yield.

Introduction
Yam (*Dioscorea spp*) is a tuber crop belonging to the genus *Dioscorea* and family *Dioscoreaceae*. The species of economic importance include *Dioscorea rotundata, D. alata, D. cayenensis, D. dumetorum, D. bulbifera and D. esculenta* (Bredeson *et al*., 2022).

Yam has been used in traditional medicine in Africa and among the Chinese and other Asiatic people to treat diseases like diabetes, to increase coronary circulation and to prevent hypercholesterolemia (Otegbayo *et al.,* 2020; World Health Organization (WHO) 2021; Adeoluwa & Afolayan, 2021). Average yam consumption per capita per day is highest in Benin Republic (364 Kcal), followed by Cote d' Ivoire (342 Kcal), Ghana (296 Kcal) and Nigeria (258 Kcal) (International Institute of Tropical Agriculture (IITA) 2022; Food and Agriculture Organization of the United

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Nations (FAOSTAT) 2023). The cultivation of yams, particularly in West Africa, is surrounded by considerable ritual (Akankpo, 2024). At each stage of the production process, rituals and traditional religious practices are performed for the success of the crop. Then, as crop maturity approaches, a date is fixed for the new-yam festival (Ugwu, 1996). Normally, farmers may not harvest or consume new yams before that date. On the appointed day, there is considerable merry-making and ritual worship to usher-in the new yams. It is noteworthy that no other crop in Africa is associated with a greater amount of social and cultural activity than the yam (Uro-Chukwu, 2024; Anyachebelu, 2021). Yam prices have been increasing in recent years due to strong demand for the crop in Africa and even in Europe and the United State of America where rapidly growing West African migrants communities still have big appetite for their traditionally preferred staple (World Bank, 2022). Nigeria exported US $27.7 million worth of yam to the United States of America in 2011 (IITA, 2023) and it is expected that much foreign exchange through yam trade would be realized in future. World production is estimated at 73million tonnes, with West Africa producing more than 93% of the crop (FAOSTAT, 2025).

Despite the usefulness of yams, the production of the crop faces serious challenges, such as weed infestation, pests, diseases and unavailability of improved planting materials as well as high cost of labour for farm operations such as land preparation, staking, weeding, harvesting and storage (Owusu *et al*., 2022). Weeds are the most economically important pest, with regards to limitations of crop yield (Chauhan, 2020). Crop losses of yams, both in the field and storage, remain a critical challenge to farmers (Weed Science Society of America (WSSA) 2022). Weed management remains a major problem in yam minisett production and is a very essential part of improved production technology in the crop. The major weed control measure by small scale farmers is hand weeding in yam. However, manual hand-weeding is costly, cumbersome, strenuous and less attractive and may require several operations depending on the dominant weeds. Therefore, several weed managements options have been adopted namely: cultural, chemical, biological, manual, mechanical and recently integrated weed management approach. This study was carried out to evaluate the effect of weed management techniques and spacings on the performance of yam minisett and to determine the optimum spacing and the most effective weeding regime in yam minisett production.

Materials and methods

The experimental site and cropping history

The study was conducted at Afaha Ikot Obio Nkan, Ibesikpo Asutan Local Government Area, Akwa Ibom State, Nigeria between May 2019 and December 2020. The area is located on latitude $5^0 2'$N and $7^0 55'$N, and longitude $56^0 6'$E and $59^0 56'$E with a mean altitude of 65 m above mean sea level (measured using the Global Positioning System (GPS), Model Garmin Extrex) manufactured by Garmin Ltd. Olathe, Kansas City, U. S. A. The area has a mean annual rainfall range of 2000 mm to 2500 mm (Akwa Ibom State, 1989). Rainfall pattern is bimodal beginning in March and ending in the month of November with peaks in June and September. Temperatures are uniformly high; annual maximum temperature is about 32.3 ^{0}C while the minimum temperature is about 23 ^{0}C. The relative humidity ranges from 75 – 85% (AKS, 1989). The vegetation of the experimental site is tropical rainforest, but much of its vegetation is being cleared for the cultivation of arable crops. Prior to this study, the experimental site had been under intensive cropping to maize, water yam and fluted pumpkin and left to fallow for one year before the present studies. The predominant weed species prior to land preparation were carpet grass, siam weed.

Experimental materials and source of collection

The experimental materials were: Yam species: *Dioscorea rotundata* (white yam) known in Akwa Ibom as "Afia Udia" and *Dioscorea alata* (water yam) known as "Abre", both obtained from the National Root Crops Research Institute (NRCRI), Umudike, Nigeria.

Experimental design

The experiment was laid out in split-split plot design with three replications. Two yam species (*Dioscorea rotundata* and *Dioscorea alata*) were the main plot treatments (Factor A); three plant spacings 50 cm x 100 cm, 75 cm x 75 cm and 50 cm x 75 cm constituted the sub-plot treatments (Factor B), while three weeding regimes (4 and 10 WAP, 6 and 12 WAP and Un-weeded) were the sub-sub plot treatments (Factor C). The gross experimental area measured 64 m x 42 m, (2688 m^2). Each main-plot measured 20 m x 20 m, sub-plots measured 20 m x 6 m while sub-sub plots were 6 m x 6 m. The replicates and the main plots were delineated by an alley of 2 m, while the sub and sub-sub plots were spaced 1m apart.

Planting and cultural operations

The mother seed yam of the two species was cut into various cylindrical pieces, each about 5 cm long. Depending on the circumference of the piece, each cylindrical piece was then cut longitudinally into four more pieces such that, each piece had a periderm (skin). Each minisett, weighed 50 g. The setts were dipped in 10 % aqueous solution of Chlorpyrifos (20 % EC) and spread under shade for one hour before planting to reduce damage by soil borne fungi and insects like termites. Setts weighing 50 g each were planted on 3/5/2019 at the crest of the ridge as dictated by respective main and sub-plot treatments, one per stand at 10 cm depth, missing stands were supplied a month after planting from the nursery to maintain a uniform rate, giving a planting population of 20,000, 17,857 and 26,666 plants/ha for 50 cm x 100 cm, 75 cm x 75 cm and 50 cm x 75 cm spacings, respectively. Three weeding regimes were imposed at 4 and 10 WAP (W1), 6 and 12 WAP (W3) and Un-weeded (W0). Staking was done at 2 Months After Planting (MAP) when the yam shoots were up to 1 m long, a single erect stake of about 3 m long was provided for each stand. At maturity of the yam, when its foliage had turned yellowish brown? and dried up, the tubers were dug up using garden fork and spade at about 6 Months After Planting (MAP) for the determination of yield data. Land preparation, planting and cultural operations were similar to that of 2020 cropping season. The experiment was repeated on 5th May, 2020 for confirmation.

Data collection

Five plants were tagged at the center of each plot for collection of data on growth and yield parameters. Assessment of the growth performance of yam was done at four weekly intervals. The leaf area (cm) was taken on yam. It was determined using the non-destructive estimation method based on leaf length and width (Epping & Laibach, 2020).

The leaf area equation is thus;

Leaf Area (cm^2) = K x L x W

Where:

K = species-specific correction factor (0.75)

L = maximum leaf area

W = maximum leaf width

The fresh weight of tubers per hectare, was determined as yield components.

Weed data were collected before the first and the second weeding, using 1m x 1m quadrat randomly thrown twice in each plot.

All data collected on growth, yield components of yam and weed density were subjected to analysis of variance (ANOVA). Treatment means were compared using Least Significant Difference (LSD) at 5% level of probability when F-value was significant.

Results

Effect of yam cultivar minisetts, spacings and weeding regimes on weed density in 2019 and 2020 cropping seasons

The effects of cultivar, spacing and weeding regimes on weed density in yam minisett plots in 2019 and 2020 cropping seasons are presented in Table 1. At first weeding (8 WAP), yam minisett weeding regimes and the interactions had significant ($p \leq 0.05$) effect on weed density in 2019 and 2020 cropping seasons. Weeding regimes significantly influenced weed density. The un-weeded plots produced the highest weed densities in 2019 and 2020 seasons. Weed densities at 4 and 10 WAP and at 6 and 12 WAP were not significantly different ($p > 0.05$) from those of the un-weeded plots in both years.

At second weeding (12 WAP), yam minisetts significantly influenced weed density in 2019 cropping season. Similarly, weeding regimes and the interactions had significant ($p \leq 0.05$) effect on weed density in 2019 and 2020 (Table 1). The highest weed density was observed in water yam plot while the lowest weed density was recorded in white yam plots in 2019 cropping season. Yam minisett spacing had no significant ($p > 0.05$) effect on weed density in 2019 and 2020. Among the weeding regimes, the un-weeded plots had the highest weed density in 2019 and 2020 cropping seasons. Significant ($p \leq 0.05$) weed density was observed in plots weeded at 4 and 10 WAP in both years.

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Table 1: Effects of cultivars, spacings and weeding regimes on weed density in yam minisett in 2019 and 2020 cropping seasons

	Weed density (m^2)			
Treatments	First weeding		Second weeding	
	2019	2020	2019	2020
Cultivars (C)				
Water yam	232.74	245.11	194.93	188.48
White yam	223.81	236.00	187.00	175.48
LSD (P≤0.05)	**Ns**	**Ns**	**17.55**	**Ns**
Spacings (S)				
75 x 75cm	229.68	243.06	187.50	179.11
50 x 75cm	225.28	236.89	189.67	181.44
50 x 100cm	229.89	246.72	195.72	185.39
LSD (P≤0.05)	**Ns**	**Ns**	**Ns**	**Ns**
Weeding regimes (W)				
6 & 12 WAP	173.33	185.72	145.28	138.78
Un-weeded	341.72	354.06	289.11	274.94
4 & 10 WAP	169.78	181.89	138.50	132.22
LSD (P≤0.05)	**19.73**	**19.64**	**21.49**	**20.86**

WAP = Weeks After Planting, Ns = Not significant, * = Significant

Interaction among yam cultivar minisetts, spacings and weeding regimes on weed density (m^{-2}) in 2019 and 2020 cropping seasons

Interactions among cultivars, spacing and weeding regimes on weed density of yam minisett in 2019 and 2020 cropping seasons are presented in Table 2. At first weeding, the result indicated the highest weed densities at 50 cm x 75 cm spacing where water yam and un-weeded treatment interacted while lower weed densities were obtained from white yam at spacing of 75 cm x 75 cm and weeding regime of 4 and 10 WAP in both 2019 and 2020 cropping seasons.

At second weeding, interactions of water yam spaced 50 cm x 100 cm or 50 cm x 75 cm when un-weeded produced significantly similar higher weed densities, while the lowest weed densities were obtained from interactions of white yam with spacings of 75 cm x 75 cm and weeded at 4 and 10 WAP in both 2019 and 2020 cropping seasons (Table 2).

Table 2: Interaction among cultivars, spacings and weeding regimes on weed density in 2019 and 2020 cropping seasons

Treatments			Weed density (m^2)			
			First weeding		Second weeding	
			2019	2020	2019	2020
C_1	75 x 75	6 & 12 WAP	184.00	198.33	159.00	144.00
		Un-weeded	328.00	341.67	258.67	246.00
		4 & 10 WAP	160.67	172.33	132.00	125.00
	50 x 75	6 & 12 WAP	169.33	181.33	141.00	133.33
		Un-weeded	313.67	322.33	269.67	254.33
		4 & 10 WAP	169.33	182.00	135.33	130.00
	50 x 100	6 & 12 WAP	172.00	182.33	142.67	134.00
		Un-weeded	347.33	362.00	300.67	280.33
		4 & 10 WAP	170.00	181.67	144.00	132.33
C_2	75 x 75	6 & 12 WAP	176.67	189.33	141.33	141.33
		Un-weeded	348.67	364.67	289.33	276.33
		4 & 10 WAP	181.33	192.00	144.67	142.00
	50 x 75	6 & 12 WAP	174.00	185.67	150.00	145.33
		Un-weeded	358.00	369.33	307.00	296.00
		4 & 10 WAP	167.33	179.67	135.00	129.67
	50 x 100	6 & 12 WAP	164.00	177.33	137.67	134.67
		Un-weeded	354.67	364.33	309.33	296.67
		4 & 10 WAP	170.00	183.67	140.00	134.33
LSD ($P \leq 0.05$)			48.32	48.10	52.65	51.10

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Effects of cultivars, spacings and weeding regimes on leaf area per plant of yam minisett in 2019 and 2020 cropping seasons

The effects of cultivars, spacings and weeding regimes on leaf area per plant of yam minisett in 2019 and 2020 cropping seasons are presented in Table 3. At 8 WAP in 2019 and 2020 cropping seasons, white yam minisetts, spacing and weeding regimes did not significantly (p>0.05) affect leaf area per plant in both years. At 12 WAP in 2019 and 2020 seasons, white yam minisetts, spacing, weeding regimes had no significant (p>0.05) effects on leaf area of yam minisett in both years. At 16 WAP, cultivars had significant effects (p≤0.05) on leaf area of yam minisett in 2019 and 2020 seasons. Among the cultivars, water yam produced larger leaf area than white yam in both years. At 20 WAP in 2019 and 2020 seasons, yam cultivar minisetts and weeding regimes significantly (p≤0.05) influenced leaf area of yam minisett. Among the cultivars, water yam produced larger leaf area than white yam in both years. Among weeding regimes, plants from plots weeded at 4 and 10 WAP gave the largest leaves which were however, similar to those from plots weeded at 6 and 12 WAP, while the un-weeded plots produced the smallest leaf area in 2019 and 2020 seasons, respectively.

Table 3: Effects of cultivars, spacings and weeding regimes of leaf area per plant of yam minisett in 2019 and 2020 cropping seasons

Treatments	Leaf area per plant							
	8WAP		12WAP		16WAP		20WAP	
	2019	2020	2019	2020	2019	2020	2019	2020
Cultivars [C]								
Water yam	553.78	582.00	2644.19	2676.22	4332.63	4373.81	6480.30	6523.70
White yam	366.56	394.81	1939.26	1969.19	3256.37	3296.52	5119.07	5162.59
LSD(P≤0.05)	**Ns**	**Ns**	**Ns**	**Ns**	**859.30**	**859.52**	**1027.00**	**1027.00**
Spacing [S]								
75*75 cm	426.94	455.06	2313.22	2345.28	3785.50	3826.72	5852.78	5896.61
50*75 cm	477.94	506.33	2103.44	2133.50	3620.28	3661.00	5545.56	5588.78
50*100 cm	475.61	503.83	2458.50	2489.33	3977.72	4017.78	6000.72	6044.06
LSD(P≤0.05)	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**
Weeding Regime [W]								
6&12 WAP	516.00	544.67	2366.28	2396.44	3997.78	4038.44	6315.22	6358.72
Un-weeded	370.11	398.28	2225.06	2257.44	3410.00	3450.17	4679.72	4723.44
4&10 WAP	494.39	522.28	2283.83	2314.22	3975.72	4016.89	6404.11	6447.28
LSD(P≤0.05)	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**	**Ns**	**1258.00**	**1258.00**

WAP = Weeks After Planting, Ns = Not significant, * = Significant

Interaction among cultivars, spacings and weeding regimes on leaf area per plant in 2019 and 2020 cropping seasons

The interaction among yam cultivar minisetts, spacings and weeding regimes on leaf area per plant are presented in Table 4. The largest leaf area per plant at 8 WAP, was observed in water yam when 50 cm x 75 cm interacted with 4 and 10 WAP weeding regime, while the least leaf area per plant was obtained from interactions of white yam by 50 cm x 75 cm by un-weeded treatment in both years. Interaction of cultivars by spacings by weeding regimes on leaf area per plant of yam minisett at 12 WAP, showed that the largest plants were observed when water yam by 50 cm x 75 cm by 4 and 10 WAP weeding regime interacted, while the least leaf area was obtained from interaction of white yam by spacing of 50 cm x 75 cm by un-weeded treatment in both years. Interaction of cultivars by spacings by weeding regimes on leaf area per plant yam minisett at 16 WAP indicated that the largest plant was observed when water yam by 50 cm x 75 cm by 4 and 10 WAP weeding regime interacted. This was however, similar with leaf area from interactions of water yam by 75 cm x 75 cm by 4 and 10 WAP weeding regime, while the least leaf area per plant was obtained from interactions of white yam by spacing of 50 cm x 75 cm by un-weeded plot in 2019 and 2020 cropping seasons. Interaction of cultivars by spacings by weeding regimes on leaf area per plant of yam minisett at 20 WAP revealed that the largest leaf area was observed when water yam, 75 cm x 75 cm and weeded at 4 and 10 WAP interacted. This was significantly similar to water yam, 50 cm x 75 cm and weeded at 4 and 10 WAP in both years, while the least leaf area per plant was observed when white yam, 50 cm x 75 cm and un-weeded treatment interacted in 2019 and 2020 cropping seasons, respectively.

Table 4: Interaction among cultivars, spacing and weeding regimes on leaf area (cm^2) in 2019 and 2020 cropping seasons

Treatments			Leaf area (cm^2)							
			8 WAP		12 WAP		16 WAP		20 WAP	
			2019	2020	2019	2020	2019	2020	2019	2020
		6 & 12 WAP	323.00	353.33	1357.00	1386.67	2894.33	2934.33	4916.67	4960.33
	75x75	Un-weeded	335.67	364.00	2097.33	2127.33	3078.33	3119.33	4224.67	4269.33
		4 & 10 WAP	494.00	520.67	2184.67	2214.67	3339.33	3380.67	5558.67	5603.33

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		6 & 12 WAP	382.00	409.67	1371.00	1401.00	2549.67	2589.67	4423.00	4466.33
C1	50 x 75	Un-weeded	126.33	154.33	895.67	924.67	1670.67	1710.00	2602.33	2645.33
		4 & 10 WAP	395.00	423.33	1441.00	1470.33	3043.67	3084.33	5284.00	5326.67
		6 & 12 WAP	618.67	648.33	3051.33	3082.33	5031.67	5072.00	7608.33	7651.33
	50 x 100	Un-weeded	378.00	406.67	3270.33	3300.33	4351.67	4390.67	5583.67	5627.67
		4 & 10 WAP	246.33	273.00	1785.00	1815.33	3348.00	3387.67	5870.33	5913.00
		6 & 12 WAP	523.33	551.00	2724.00	2765.33	4735.33	4778.00	7519.00	7562.67
	75 x 75	Un-weeded	296.33	324.00	2373.00	2404.00	3493.00	3534.33	5190.00	5232.33
		4 & 10 WAP	589.33	617.33	3143.33	3173.67	5172.67	5213.67	7707.67	7751.67
		6 & 12 WAP	538.00	566.67	2181.67	2212.33	4272.33	4313.00	6703.67	6747.33
C2	50 x 75	Un-weeded	706.00	734.00	2820.67	2851.67	4917.67	4960.67	6635.67	6680.67
		4 & 10 WAP	720.33	750.00	3910.67	3941.00	5267.67	5308.33	7624.67	7666.33
		6 & 12 WAP	711.00	739.00	2665.33	2697.00	4503.33	4543.67	6720.67	6764.33
	50 x 100	Un-weeded	378.33	406.67	1650.67	1681.33	2598.67	2638.33	3842.00	3885.33
		4 & 10 WAP	521.33	549.33	2328.33	2359.67	4033.00	4074.33	6379.33	6422.67
LSD ($P \leq 0.05$)			427.33	427.00	2135.00	2578.00	2578.00	2579.00	3081.00	3081.00

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Fresh Tuber Yield (t ha^{-1})

The effects of yam cultivar minisetts, spacings and weeding regimes on fresh tubers yield of yam cultivar minisett in 2019 and 2020 cropping seasons are presented in Table 5. The result indicated that spacing of yam cultivar minisetts, and weeding regimes significantly ($p \leq 0.05$) influenced fresh tubers yield in 2019 and 2020 seasons. Among the yam cultivar, water yam minisetts produced significantly, higher tuber yield (t ha^{-1}) than white yam in 2019 and 2020 seasons. Within the spacings, the highest tubers yield (t ha^{-1}) was produced by yam minisett spaced 50 cm x 75 cm, while spacing of 75 cm x 75 cm produced yam minisett with the least fresh tuber yield (t ha) in 2019 cropping seasons. Among the weeding regimes, weeding at 4 and 10 WAP or 6 & 12 WAP produced yam minisett plants that gave statistically similar fresh tuber yield in (t ha^{-1}), while the least fresh tuber yield was observed in plots that were un-weeded in 2020.

Table 5: Effects of cultivars, spacings and weeding regimes on fresh tuber yield (t ha^{-1}) of yam minisett in 2019 and 2020 cropping seasons

	Fresh tuber yield (t ha^{-1})	
	2019	2020
Cultivars [C]		
Water yam	12.21	13.13
White yam	7.80	7.46
Mean	10.01	10.30
LSD(P≤0.05)	2.80	2.79
Spacing [S]		
75*75 cm	6.78	8.72
50*75 cm	15.23	11.33
50*100 cm	8.00	10.82
Mean	10.01	10.29
LSD(P≤0.05)	3.46	Ns
Weeding Regime [W]		
6 & 12 WAP	10.44	10.81
Un-weeded	8.06	7.97
4&10 WAP	11.54	12.10
LSD(P≤0.05)	Ns	3.41

Interaction among yam cultivar minisetts, spacings and weeding regimes on fresh tuber yield (t/ha) in 2019 and 2020 cropping seasons

Interaction among yam cultivar minisetts, spacings and weeding regimes on fresh tuber yield (t/ha) in 2019 and 2020 cropping seasons are presented in Table 6. The highest fresh tuber yield (t/ha) was produced by water yam spaced 50 cm x 75 cm and weeded at 4 & 10 WAP, while the least fresh tuber yield (t/ha) was recorded from interactions of white yam by spacing of 75 cm x 75 cm by un-weeded plots in both 2019 and 2020 cropping seasons.

Table 6: Interaction among cultivars, spacing and weeding regimes on fresh tuber yield (t ha^{-1}) in 2019 and 2020 cropping seasons

Treatments			Fresh tuber yield (t ha^{-1})	
			2019	2020
		6 & 12 WAP	8.40	8.47
	75 x 75	Un-weeded	4.53	11.50
		4 & 10 WAP	5.97	9.40
		6 & 12 WAP	11.87	8.83
C_1	50 x 75	Un-weeded	4.17	4.20
		4 & 10 WAP	11.83	16.50
		6 & 12 WAP	5.83	5.13
	50 x 100	Un-weeded	5.47	9.93
		4 & 10 WAP	12.23	5.53
		6 & 12 WAP	9.30	8.97
	75 x 75	Un-weeded	5.83	6.97
		4 & 10 WAP	6.63	7.03
		6 & 12 WAP	19.30	19.60
C_2	50 x 75	Un-weeded	18.97	10.13
		4 & 10 WAP	25.40	28.37
		6 & 12 WAP	7.93	10.17
	50 x 100	Un-weeded	9.40	6.70
		4 & 10 WAP	7.17	7.80
LSD (P≤0.05)			8.47	8.36

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Discussion

The weed density in 2019 and 2020 significantly affected the cultivars and weeding regimes. An increase in weed infestation as reflected in the low tuber yield of water yam cultivar could be attributed to the accumulation of favourable resources over time. This observation is in consonance with the findings of Eghball *et al.,* 2004) who reported that increase in nitrogen fertilizer rates with high weed density results in little improvement in crop yield but tends to increase weed growth and competitiveness. The un-weeded plots produced the highest weed density in all the studies, because no weed control measure was carried out in any form. Uncontrolled weed infestation results in significant crop yield reduction. Because of undesirable effects of weeds in crop production, weeds are the most dengerous pests of tropical agriculture (Akobundu, 1987; Melifonwu, 1994). Effective weed management is a major concern in any meaningful crop production endeavour (Buhler, 2002).

Leaf area was significantly affected by yam cultivar minisetts at 20 WAP and that water yam (*Dioscorea alata*) was more superior to white yam (*Dioscorea rotundata*) in all the parameters studied. The present findings are further supported earlier works by Ndaeyo *et al.* (2013), who attributed observed differences in cocoyam growth, yield and their components to inherent varietal characteristics. Similarly, Udosen *et al.* (2017) and Reyes-Gastro *et al.* (2005), reported a differential response of some genotypes of X. *violaceum* to varying climatic condition at different location in Nicaragua. Where the response of yam cultivar minisetts to spacings and weeding regimes were assessed. Water yam cultivar produced the highest fresh tuber yield than white yam cultivar minisetts in both 2019 and 2020 cropping seasons, respectively. This higher tuber yield (t/ha) was due to varietal characteristics predicated on the fact that, water yam minisett cultivar had significantly higher fresh tuber yield. These findings agree with the report of Ndaeyo *et al.* (2013) who reported differences in growth, yield and yield components among cocoyam cultivars and attributed it to inherent varietal characteristics. Inherent varietal characteristics might be responsible for the ability of water yam cultivar to draw more on available growth resources and produce higher fresh tuber yield (t/ha) than white yam cultivar.

The result showed that the spacing for yam also significantly influenced the yield and yield components of yam cultivars in 2019 and 2020 cropping seasons respectively. Spacing of 50 cm x 75 cm produced yam minisett with the highest fresh tuber yield (t/ha) in 2019, while the spacing of yam minisett of either 50 cm x 100 cm or 75 cm x 75 cm produced yam with least fresh tuber yield (t/ha) in 2019 and 2020 cropping seasons respectively. The lowest yield obtained from the spacing of either 50 cm x 100 cm or 75 cm x 75 cm indicated that, wider spacings were able to produce but not high enough to compensate for the loss of soil area associated with lower densities. These findings agree with the report of Kahsay, *et al.,* (2014) on onion, where the wider inter-row spacing of 10 cm gave the lowest total bulb yield (28.5 t/ha) as against those obtained at narrow inter-row spacing of 5 cm (36.1 t/ha) and 7.5 cm (33.8 t/ha).

The result showed that in 2019 and 2020 cropping seasons, weeding regime significantly influenced fresh tuber yield (t/ha) of yam minisett in 2020 cropping season. Weeding at 4 and 10 WAP produced yam minisett with the highest fresh tuber yields (t/ha) in 2020 cropping season, while un-weeded treatments recorded the lowest yield which may be attributed to the fact that the weeds and crop competed for available nutrients, space and light (Rajan and Swanton, 2001). The result of the present study corroborated the findings of Udosen *et al*. (2016) reported tuberous root yield loss of about 76.8 % of cocoyam in the un-weeded plots. Similarly, Braum *et al*. (1991) who reported that if weeds are left uncontrolled, they can seriously reduce crop yield. Individual crop losses due to weed competition vary from crop to crop and region to region for the same crop in response to many factors.

The interaction significant effect showed that the highest fresh tuber yield (t/ha) of 18.62 and 19.27 t/ha were obtained from 50 cm x 75 cm spacing plots, weeded at 4 and 10 WAP in 2019 and 2020 cropping seasons respectively. This observation emphasizes the benefit of optimum spacing and early weeding in increasing yield of yam minisett.

Conclusion

Based on the findings of this study, farmers in Uyo should invest in the production of water yam cultivar, with the spacing of 50 cm x 75 cm accompanied with early weeding at 4 and 10 WAP.

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