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Effects of Weed Suppressant on Yield Productivity of Cassava (*Manhihot Esculenta* Crantz) In Uyo, Southern Nigeria

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ABSTRACT

Field experiment was conducted in 2021nd 2022 cropping seasons at National Cereals Research Institute (NCRI), Uyo, Akwa Ibom State, Nigeria, to assess yield productivity of cassava and economic return to management (₦ha^{-1}) under cover crop crops as weed suppressant. The experiment was laid out in randomized complete block design. The treatments were non-weeded plot, weeded plot, cassava intercrops with vegetable cowpea, egusi melon and cucumber. The cassava storage root yield differs significantly ($p<0.05$) in both cropping seasons. The treatment of manual hand weeding produced significant larger root tuber yields, 32.25 and 34.25 t/ha in 2021 and 2022 cropping seasons, respectively. Cassava storage root yield recorded in cowpea treatment was 28.71 and 26.75 t/ha in 2021 and 2022 cropping seasons, respectively. Cassava intercrop with egusi melon produced 26.98 and 26.62 t/ha, respectively. Cassava intercrop with cucumber produced storage root yield of 26.31 and 25.39 t/ha in both cropping seasons. The least storage root yield were 8.01 and 8.23 t/ha in 2021 and 2022 cropping seasons, respectively. Result showed that manual weeded treatment produced 11-75% and 22-76% higher storage root yield compared to the other treatments in both cropping seasons. Comparing the cost of production and economic returns to management. Treatment of manual hoe weeding 3 times, resulted to highest cost of production; ₦ 218, 500 and 240,500 in both cropping seasons. Cowpea and egusi melon as weed suppressant had; 135,000 and 146,500 total cost of production while the least; ₦ 129,500 and 177,500 in both cropping seasons, was recorded in control (no weeding) treatment. Highest economic returns to management, ₦ 3780880 and ₦ 4266610 with respective cost/benefit ratios of 28.3 and 29.5 in 2015 and 2016 cropping seasons, respectively. This was followed by ₦ 3556200 and ₦ 3899490 with cost/benefit ratio of 27.3 and 26.6 in 2021 and 2022, respectively. The treatment of manual hoe weeding three times; ₦ 3393500 and ₦ 4040750 with cost/benefit of 16.53 and 17.80 in 2021 and 2022 cropping seasons, respectively. The study suggests that intercropping cassava variety-TMS98/0505 with cover crop as weed suppressant could sustainable enhance farmer's income.

Keywords: Weed suppressant, Inter crop, Cropping systems, Cassava. Yield productivity

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INTRODUCTION

Cassava (*Manhihot esculenta* Crantz) is major source of carbohydrate and cheap energy food staple in Nigeria. Cassava is highly adaptable crop that can grow well in many different regions worldwide, making it an important cash crop for many countries especially in tropical Africa, as well as in Asia and South America. Cassava represents the significant source of sustenance and nutrition for many people in sub-Sahara region (Ikeh, 2017; Ikeh et al, 2023a). It is worthy to note that cassava occupied a strategic position among the cultivated crops in Nigeria, especially in rainforest, savannah and guinea savannah regions. Global cassava production has been increasing continuously since 1999 till date.

Nigeria is by far the world's biggest and most consistent cassava producer worldwide. However, Thailand is the world's largest supplier of cassava, as it is currently responsible for roughly 70 percent of total world exports. Together with Nigeria, Thailand, Indonesia, Brazil, and the Democratic Republic of Congo produce about 70 percent of the world's total cassava. However, much of that output is locally consumed. As of 2023, the following countries have some of the highest annual rates of cassava production: Nigeria: 60 million metric tons, Democratic Republic of Congo: 41 million metric tons, Thailand: 29 million metric tons, Ghana: 21.8 million metric tons, Indonesia: 18.3 million metric tons, Brazil: 18.2 million metric tons, Vietnam: 10.5 million metric tons, Angola: 8.8 million metric tons (FAO STAT,2023). Consequently, a significant part of the population across the globe depends on cassava processing for sustenance as it provides food as well as occupation to farmers and traders. Apart from this, cassava exhibits thickening properties and is therefore utilized in numerous applications across the food and beverage, paper and cardboard, animal feed, ethanol, pharmaceutical, adhesives, and textile industries. It is one of the most popular raw materials for starch production in the tropics. It's refers as the third most important crop in the tropical regions after rice and maize. Cassava is a rich source of carbohydrates in Nigeria and is available in the form of garri, fufu (akpu), abacha, chips, pellets, flour and starch. The crop can be grown all year round (Ikeh et al. 2023b).

Realizing the economic significance of cassava production in the tropics, efforts have been made to improve the yield through different methods of crop improvement. The yield of cassava has improved with the adoption of improved technologies. Yield has significantly increased in all most all cassava production areas in Nigeria. (IITA, 2006). In Nigeria some major challenges to cassava production especially in high humid ecology of zone is high cost of land preparation and weeding. Majority of subsistence cassava farmers in West Africa usually adopt cultural methods of weed control and management in terms of manual hoe weeding, hand pulling, mulching, tillage, mix cropping and intercropping with low other crops especially legumes and other arable crops.

In west, central and east Africa the use of cropping systems as method of weed management is still dominated by small-holding farmers. Comparing all the farm operations, manual weeding consumes greater number of total labour budget. Cultural weed control is usually labour intensive. Cultivation of arable crops in the sub-Sahara region is usually associated with weed growth which is difficult to control especially perennial and parasitic weeds (Iyagba, 2010). Chikoye (2000), revealed that information on the total economic impact of weeds on many crops in Nigeria has not been properly revealed and documented. The reason could be that the methods for estimating yield losses often differs within the crop types, varieties and ecology, this do not allow easy comparison of weed losses results from different agricultural ecology of Nigeria. However, Oerke et al. (1994) indicated that a loss due to weeds in cassava was about 48 – 90 %.This percentage yield loss was substantial. In order to reduce this high percentage of yield loss, cassava farmers spent large proportion of their resource for weed control and management. Nkakini et al. (2006) recorded that farmers in southern Nigeria utilized 43.8 man days/ha for ridging and cassava planting, 57.8 man days/ha for mound making and yam planting while general weeding used 40.0 man days/ha and root weeding using 36.7 man days/ha. Nkakini et al. (2006) further noted that farmers in southern Nigeria spent energy of 317.09 MJ in weeding yam/cassava compare to 345.60 MJ per hectare for general weeding using manual labour.

The small scale farmers because of low income status prefer to use hand weeding to control weeds in their cassava farm. This probably is the oldest method of weed control (Iyagba, 2010). In cassava, poor timing of hoe weeding resulting from other farm demands on the farmers' time during the first 3 months accounts for most of the yield losses associated with weeds in the crop (Iyagba, 2010). The recommended hand weeding regime for cassava is 3, 8 and 12 weeks after planting (WAP) in Nigeria (IITA, 1990; NACWC, 1994). What was considered in the recommendation could be for yield not returns to management. The use of cover crop (cover crops) in biological control or suppression of weeds by the action of one or more organisms, through natural means or by manipulation of weeds, organism, or environments is not new in southeastern agro-ecology of Nigeria only that actual benefits in terms of income are not known. Egusi melon, vegetable cowpea (akidi) and cucumber grows well in the zone. All of these crops commonly see growing in intercrop with root and other field crops like maize. They role in weed control has not been properly documented. This study was carried out in order to determine the yield productivity of cassava and economic return to management under different cover crop crops as weed suppressant. The results of this study will be useful and adopted since all the component crops are not new to the study area.

MATERIALS AND METHODS

The study was carried out in 2021 and 2022 cropping seasons at National Cereals Research Institute, Uyo, Akwa Ibom State, Nigeria. Uyo is located in latitude $5^0$17' and $5^0$27'N, longitude $7^0$27' and $7^0$58'E and altitude 38.1m above sea level. This rainforest zone receives about 2500mm rainfall annually, with mean relative humidity of 78% atmospheric temperature of 30^0c and means sunshine hours of 12 (Peters et al. 1989). A randomised complete block design with three replicate was used. The treatments were different biological weed managements with cover crop crops (no weeding, weeded 3x, cassava + cowpea, cassava + melon). The experimental plot size was 10 x 10m. In both years, planting was done in April using stem cuttings with 8 nodes at a spacing of 1m x 1m on the crest of the ridges while cowpea and egusi melon were planted at $^2/_3$ of the ridges at plant population of 20, 000 plants per hectare. A popular cassava variety 98/TMS 0505 was used. Sound agronomic practices were put in place except weeding. The following data were collected from cassava; weed density, weed biomass and storage root yield were analysed using analysis of variance, significant means were compared with least significant difference at 5% probability. Cost of production and economic returns to management as influenced by weed management was analysed using the partial budgeting method to determine the economic returns to cassava farmers.

RESULTS

Weed density as influenced by weed control method is presented in Table 1 varied significantly different among the weed management methods in both cropping seasons. The treatment of no weeding had significant higher number of density; 137.67, 233.33 and 285.10 at 1, 2 and 3 months after planting (MAP) in first cropping season. In second cropping season, the following corresponding weed density of 148.70, 247.50 and 301.23 per m^2 was recorded in control (no weeding) treatment. The least number of weed density at 2 and 3 months after planting was recorded in three times weeding treatment. The weed density recorded at 2 MAP in weeded 3x treatment was 33.34 and 42.04 per M^2 in both cropping seasons. At 3MAP, the density recorded in the treatment of three times weeding was 74.81 and 78.44 per M^2 in both cropping seasons, respectively.

Weed biomass as influenced by weed management methods is shown in Table 2. The result showed significant difference ($p<0.05$) among the treatments. Treatment of no weeding had significant higher weed biomass of 156.56 and 231.55 g at 2 and 3 MAP in first trial. In the second trial, weed biomass recorded was 155.11 and 240.22 g, respectively. Treatment manual weeding 3x had weed biomass of 60.21 and 87.60 g in first trial while 63.45 and 90.33 g, respectively was recorded in manual weeding in the second trial. In both cropping seasons, treatment of egusi melon as weed suppressant had 102.82 and 90.32 g weed biomass while 109.33 and 121.12 g, respectively was recorded in treatment of cowpea as weed suppressant.

Number of leaves per plant as influenced by weed management is shown in Table 3. The treatment showed significant difference for number of leaves per plant ($p<0.05$). The weeded plot had plants with highest number of leaves per plant, 50.33, 83.30, 118.30 and 143.40 at 2, 3, 4 and 5 months after planting (MAP) in 2021. In 2022, the following number of leaves per plant; 69.33, 90.03, 125.11 and 163.40 respectively was recorded in manual hand weeding. No weeding treatment (control) produced the least number of leaves per plant, 35.61, 52.11, 68.16 and 70.30 at 2, 3, 4, and 5 MAP in 2021 while the following; 69.33, 90.03, 125.11 and 163.40, respectively in 2022.

Table 1: Weed Density per M^2 as influenced by Weed management

Weed Management Methods	2021			2022		
	Months after planting			Months after planting		
	1	**2**	**3**	**1**	**2**	**3**
No weeding	137.67	233.33	285.10	148.70	247.50	301.23
Weeded 3x	136.11	33.34	74.81	128.33	42.04	78.44
Cassava + Cowpea	69.45	40.77	101.33	55.16	51.76	110.22
Cassava + Melon	45.32	55.45	88.45	50.70	58.67	97.33
Cassava + Cucumber	70.11	90.13	123.12	74.12	70.80	121.45
LSD(p<0.05)	3.33	5.60	9.29	3.51	6.10	11.03

Table 2: Weed Biomass (g) as influenced by Weed management

Weed Management Methods	2021			2022		
	Months after planting			Months after planting		
	1	2	3	1	2	3
No weeding	106.89	156.56	231.55	60.33	155.11	240.22
Weeded 3x	108.88	60.21	87.60	59.81	63.45	90.33
Cassava + Cowpea	60.11	77.33	109.33	60.13	79.77	121.12
Cassava + Melon	58.83	79.43	102.82	59.23	81.34	90.32
Cassava + Cucumber	59.01	85.10	117.55	61.45	87.40	117.90
LSD(p<0.05)	NS	5.31	11.33	NS	6.20	10.76

*NS=not significant

Table 3: Number of Leaves per Plant as Influenced by Weed Management Methods

Treatments	2021				2022			
	Months after planting				Months after planting			
	2	3	4	5	2	3	4	5
No weeding	35.61	52.11	68.160	70.30	45.11	57.61	70.12	80.60
Weeded 3x	50.33	83.30	118.30	143.40	69.35	90.03	125.11	163.40
Cassava + Cowpea	48.48	75.40	101.25	135.30	60.60	88.33	121.60	152.41
Cassava + Melon	44.33	75.12	113.30	138.40	62.25	88.70	119.25	148.25
Cassava + Cucumber	44.30	70.33	98.78	120.30	59.35	73.40	109.11	134.40
LSD(p<0.05)	3.01	5.33	7.41	8.04	3.40	4.88	5.90	7.91

Table 4: Leaf Area (Cm^2) as Influenced by Weed Management Methods

Treatments	2021				**2022**			
	Months after planting				Months after planting			
	2	3	4	5	2	3	4	5
No weeding	173.90	173.11	170.61	170.01	169.03	170.16	171.81	170.51
Weeded 3x	192.10	198.80	205.11	221.33	188.05	199.25	218.80	240.80
Cassava + Cowpea	184.33	186.33	198.30	218.56	185.65	192.30	206.60	212.62
Cassava + Melon	185.60	186.25	198.75	215.35	178.30	193.45	201.89	210.11
Cassava + Cucumber	182.75	184.99	192.18	209.05	176.59	190.11	198.45	200.33
LSD(p<0.05)	2.20	2.31	4.58	4.77	2.33	2.41	3.67	5.11

Table 5: Number of Branches as Influenced by Weed Management Methods

	2021				2022			
	Months after planting				Months after planting			
Treatments	2	3	4	5	2	3	4	5
No weeding	3.01	3.41	3.91	4.35	2.55	3.12	3.55	4.03
Weeded 3x	8.60	11.30	18.31	21.30	7.33	10.60	16.16	20.11
Cassava + Cowpea	8.10	10.45	15.85	18.40	7.15	9.25	13.18	16.25
Cassava + Melon	8.40	10.33	15.31	17.30	7.12	9.16	12.75	16.05
Cassava + Cucumber	7.53	10.03	13.60	16.31	6.56	8.60	11.18	13.53
LSD(p<0.05)	1.76	2.11	3.30	3.60	2.32	2.91	3.14	3.36

Table 6: Yield and different Land Equivalent Ratios (LER) as Influenced by Weed Management Methods

Treatments	2021			2022		
	Cassava	Component Crops	LER	Cassava	Component Crops	LER
No weeding	8.01	-	-	8.23	-	-
Weeded 3x	32.25	-	-	34.25	-	-
Cassava + Cowpea	28.71	8.21	1.22	26.75	9.12	1.23
Cassava + Melon	26.98	5.16	1.06	26.12	5.10	1.08
Cassava + Cucumber	26.31	11.31	1.24	25.39	12.18	1.28
LSD(p<0.05)	3.20	-	-	3.37	-	-

Table 7: Cost of production and economic return to management (₦ha^{-1}) as influenced by weed management methods

Weeding	Treatments					Treatment				
2021						2022				
Farm operation	No weeding	Weeded	Cowpea	Melon	Cucumber	No weeding	Weeded	Cowpea	Melon	Cucumber
(A) Production Cost (₦/ha)										
1. Land preparation	48,000	48,000	48,000	48,000	48,000	56,000	56,000	56,000	56,000	56,000
2. Fertilizer/ applicatio	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
3. Planting materials	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500
4. Labour	36,000	125,000	42,000	42,000	45,000	38,000	139,000	45,000	45,000	48,000
Total cost of production (TCP) a	129,500	218,500	135,500	135,500	138,500	177,500	240,500	146,500	146,500	149,500
(B) Yield (t/ha)										
Cassava	8.01	32.25	28.71	26.98	26.31	8.23	34.25	26.75	26.62	25.39
Component crops	-	-	8.21	5.16	11.31	-	-	9.12	5.10	12.18
(C) Gross Revenue (GB)[b]	897120	3612000	3691700	3481000	3919380	1028750	4281250	4045990	3812000	4416110
(D) Net returns to Management (NRM) c	767620	3393500	3556200	3345500	3780880	851250	4040750	3899490	3665500	4266610
Benefit/cost ratio	6.9	16.53	27.3	25.7	28.3	5.8	17.80	26.6	25.0	29.5

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a) Labour cost is for planting, and weeding.

b) Yield x unit price of ₦112,000 per tonne of cassava, ₦58,00 per tonne of vegetable cowpea, ₦89,000 per tonne of melon, and 86,000 per tonne of cucumber in 2021 and ₦125,000 per tonne of cassava, ₦77,000 per tonne of vegetable cowpea, 95,000 per tonne of melon and 92,000 per tonne of cucumber in 2022 based on prevailing market price at time of harvest.

The results of leaf area as influenced by different weed management varied significantly different ($p<0.05$) in both cropping seasons (Table 4). The manual weeded treatment had significant larger leaf area in all the sample months in both cropping season. The least was recorded in control (no weeding).

Number of branches per plant as influenced by weed management method is shown in Table 5. The result of number of branches per plant differed significantly different ($p<0.05$) in 2015 and 2016 cropping seasons, respectively. The manual weed treatment and treatments of intercrop ($p<0.05$) produced significantly number of branches over no weeding treatment. At 5 MAP, weeded treatment produced 21.30 and 20.11 number of branches in 2021 and 2022 cropping seasons respectively.

Yield of cassava as influenced by weed management method showed significant difference ($p<0.05$) among the treatments (Table 3). The treatment of manual weeding, produced significant highest storage root yield; 32.25 and 34.25 t/ha in 2021and 2022 respectively, followed by cassava intercrop with vegetable cowpea, 28.71 and 26.75 t/ha, cassava intercropped with egusi melon, 26.98 and 26.62 t/ha and cassava intercrop with cucumber, 26.31 and 25.39 t/ha respectively. The least storage root yield 8.01 and 8.23 t/ha in both cropping seasons was obtained from control treatment (no weeding).

The yields of component crops were also shown in Table 3. Vegetable cowpea had 8.21 and 9.12 t/ha pulse yield, egusi melon had seed yield of 5.16 and 5.10 t/ha, cucumber, 11.31 and 12.18 t/ha of fresh fruit yield in 2021 and 2022 respectively.

The cost of production and economic returns to management are shown in Table 5. In both years, the highest cost of production 218,500.00 and 240,500.00 was observed under weeded (3x) treatment while the least was from non-weeded treatment 129,500.00 and 177,500.00 in 2021 and 2022 respectively. The use of cucumber as suppressant to weed treatment gave highest economic return to management, ₦3780880.00 and ₦4266610.00 in 2021 and 2022 respectively (Table 5). However, the highest benefit-cost ratios (28.3 and 29.5) for cassava intercrop with cucumber, (27.3 and 26.6) for cassava intercropped with vegetable cowpea and (25.7 and 25.00) for cassava intercropped with egusi melon compare to weeded plot of 16.53 and 17.80 benefit-cost ratio in 2021 and 2022 respectively. The highest benefit cost ratio recorded in cassava with cover crop crops was due, no extra cost for weeding and additional incomes from sales of cowpea pulse, egusi melon seeds and cucumber fruits. The cassava/cucumber intercrop showed superior economic returns with 10 – 80 % and 5 – 80 % increase in 2021 and 2022 respectively.

DISCUSSIONS

The result of the experiment showed that hoe weeding treatment produced significant and appreciable storage root yield in both cropping seasons compared to the other weed management methods. The reduction in yield with treatments of cassava with low growing crops could be attributed to completion of the cassava plant with the component crops. The least yield of cassava storage root in the treatment of no weeding (control) could equally attributed to higher competition for nutrients and space between cassava and weeds. This observation could confirm with higher weed density and biomass recorded in the no weeding treatment. This observation proof how important or significance of weeding to cassava. The result observed was in consonance with the report of Akata et al. (2016) that weed constituting the major constraints to cassava production. Ikeh, 2017 reported that weed control and management of different cassava genotypes differs, therefore, cost effective method of weed control should be based on cassava variety which differs in morphology and branching habits. This observation agrees with early findings of Onochie (1978); Akobundu (1991) and Akata et al. (2016) that cassava is due to its slow rate of initial growth makes it a poor weed competitor. Onochie (1978) further revealed that cassava is one of root crop susceptible to sever weed competition at its early stage of growth. The ability of intercrops with to perform better than non-weeded plot could be due to their ability to suppress weeds at early stage in the field. This agrees with findings Iyagba (2010) who reported that weeds which emerge during the first three months after planting are known to endanger yields more than those appearing later.

Onochie (1978) further stated that most damaging effect on yield was weed competition with cassava plants during canopy formation and early tuberisation (third months after planting) and less from the 4th month until harvest.

The lesser yield of storage root observed in intercrop could be due to inability of the crop to control weeds effectively and also competition the crops induced to cassava plant while suppressing weeds. This observation is consonance with findings of Ikeh et al. (2012) that when two or more plant species are grown in close proximity as intercropping, there is the tendency for them to compete for environmental resources of air and soil. The result of LER shows that intercropping cassava with vegetable cowpea, egusi melon and cucumber had more advantage than planting cassava sole. This in line with findings of Ikeh et al. (2012), that intercropping yam with egusi melon had more advantage than sole crop. Also higher storage root yield observed in cowpea cassava intercrop compared to the other intercrop treatments could be that cowpea had affinity to fix nitrogen in the soil which could have enhanced the soil fertility status, invariably resulted to higher yield. This agrees with Ikeh et al. (2023c) that cowpea has ability to fix nitrogen to the soil through nitrogen fixation and organic matter from the decay cowpea plant biomass.

The highest cost of production observed the treatment of manual hoe weeding 3 times was as result of number of times manual weeding operations was taken which involves additional cost compared to the other weed management methods. Lesser cost of production in the treatment of no weeding was as a result of no cost incurred in the treatment. Highest economic returns to management recorded in cassava intercrop with cucumber, cowpea and melon were as a result of another source of income from the component crops. The low economic return recorded in no weeding treatment was as result of low cassava storage root recorded from the treatment.

CONCLUSION

For Nigeria to maintain her key position in cassava production, the ideal and economic weed control and management must be identify and adopted. This study suggests that it may be more economical to intercrop with cover crop crops with cassava in order to reduce weed competition with cassava and also to achieve additional yields from the component crops. This could help to save time, cost and also increase farmers' income.

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