Phytology

Impact of hoe weeding levels on maize and cassava yields in an intercrop

Obiazi C. C.

Department of Agronomy, Delta State University, Abraka, Nigeria

Correspondence Author: Obiazi C. C.

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Abstract

Weeds depress yields of crops in mixtures. Intercrops sometimes differ in farm duration and weed management requirements. Maize and cassava vary in their farm duration. Average dry maize grain yields were 3.0 Weed Free (WF) = 3.0 (Hoe-weeded three times) (HW3)> 2.9 Hoe-Weeded two times (HW2)> 2.5 (Weedy check)> 2.3 t/ha (HW1). The average yield of cassava fresh tubers were 33.0 (WF)> 26.1 (HW3)> 22.3 (HW2)> 9.7 (HW1)> 6.3 t/ha (weedy check). One or two hoe-weeding was sufficient for appreciable yield of maize, while the third weeding at nine weeks was more beneficial for cassava than for maize. In a cassava maize mixture, three hoe-weeding is recommended for suitable yield of cassava in the mixture.

Keywords: weed control, crop mixture, crop yield, levels of hoe weeding

Introduction

Maize provides nutrients in a compact form, if dried very well it can store for a very long time and be transported easily (Onwueme and Sinha, 1991) [14]. Generally, maize is used in the manufacture of animal feed. It is extensively processed into a range of products like: cornmeal, breakfast cereals flour, grits, tortillas, starch and snacks (Mehta and Dias, 1999) [9]. The United States of America is the world largest maize producer; out of the total global maize output, United States of America accounts for about 35%. Maize is acknowledged as mother grain of Americans and the US economy is driven by the crop (Milind and Isha, 2013) [10]. Globally, maize yield loss due to weed interference are estimated to be around 37% and that weed infestation has been reported to be a major cause among the factors that lead to between 20 and 80% reduction in the yield of maize as noted Shrestha, *et al.* (2019) [15]. Uncontrolled weed growth in maize causes grain yield reductions of as much as 60% in the early season and 75% in the late season in Nigeria as reported by Ayeni *et al.* (1984) [4]. Critical period of weed interference is from two to six weeks after the sowing of maize and critical period of weed interference is between four and seven weeks after maize sowing (Shrestha, *et al.* 2019) [15].

Widespread adoption of cassava varieties that are high-yielding, improved disease control as well as value addition skills have brought about a drastic increase in the production, consumption and processing of cassava in Nigeria (Amadi and Ezeh, 2018) [3]. Cassava is used as food for man, and feed for livestock and as a raw material for industries (Obiazi, 2018) [12]. Cassava is one of the most productive crops in the world (Obiazi and Ojobor, 2013). Hand-weeding at 3+8+12 weeks after planting resulted in 28 t/ha of root tuber, this was the highest average yield as recorded by (Alibi *et al.* 1999) [2]. The practice of hoe-weeding is common in Africa among cassava farmers (Melifonwu 1994) [8]. Weeds are ever-present and substantially decrease quality and yield of crops.

In cassava, the critical period required for the removal of weed is from planting till twelve weeks (Melifonwu 1994) [8]. In cassava production, weed infestation is a constraint and its management is presently the foundation of increased production of the crop. Weed management in cassava farms, is the highest labour-demanding field operation (Agahiu *et al.* 2011) [1]. TMS 30572 is one of the cassava varieties that combine high yield with the ability to suppress weeds.

Cassava, like most field crops, is negatively affected by weed interference that can be mostly weakening at the early cassava growth stage due to its initial slow growth. Intercropping with cover crops can be used in a resource poor situation as a way to keep down weed pressure in the farm, certain benefits could be enjoyed such as enhanced weed control efficacy due to additional vegetation cover in the mixture which results in more ground cover causing shortage of the right spectrum of light rays that would have initiated the germination process of weed propagules that are present in the top soil, the component crop also supplies extra food. Obiazi (1991) [11] noted that, traditionally, planting of cassava is done in mixture. Melon and maize are crops usually planted together with cassava. In this study, cassava was planted in mixture with maize.

Using herbicides for weed management in crop production is now a common place but the price tag of most herbicides and the concern for environmental safety constrain most peasant farmers to resort to hoe-weeding. In some economies too, the trending issue is organic agriculture, with serious ecological concerns. Resort to hoe-weeding provides answer to some of the challenges stated above. Doing hoe weeding more than the required number times has its detrimental financial implications; this study was therefore set-up to determine the yield response of maize and cassava to three different levels of hoe-weeding.

Materials and Methods

Description of the study area

The experiment was conducted at the Agronomy Department Research Field located in the erstwhile Asaba Campus of Delta State University, Nigeria. Asaba is situated between Lat. 6º 14' N, Long. 6º 49' E. Asaba is in the southern Nigeria within the rain forest zone. Rainy season which is bimodal in pattern starts in April and ends in November, the first peak comes up in June while the second peak is in September.

Research design

Three levels of hoe-weeding were tested in this study, these were hoe-weeding at 3 Weeks After Sowing (WAS) (H3), hoe-weeding at 3 and 6 WAS (H3+6) and hoe-weeding at 3, 6 and 9 WAS (H3+6+9); the controls were Weed Free (WF) and Weedy Check (WC); weed free plots were kept weed free by weeding every two weeks for the first three months; from four months, weed free plots were kept weed free by weeding every four weeks. Cassava variety TMS 30572 and maize variety TZSR-Y were used in the study. The cassava used in the study, TMS 30572, was reported by Obiazi (1991) [11] to combine high yield with ability to suppress weeds.

Each treatment plot occupied a land area of 16 m^2 measuring 4 m x 4 m. A path of 50 cm width separated the adjacent plots within a replicate, while a path of 100 cm width separated adjacent blocks. Randomized Complete Block Design (RCBD) was used to lay out the treatments which was replicated trice.

Land preparation and crop establishment

Land was prepared by ploughing and stomps and large plant materials were picked. The land had the following soil properties as shown in Table 1.0; the soil had pH value of 5.6, total N was 0.9 g kg^{-1}, while the values of available P was 14.0 mg kg^{-1} and K was 0.32 c mol kg^{-1}. The soil had 816 g kg^{-1} of sand, 71 g kg^{-1} of silt while the value of clay was 113 $kg^{-1}$of soil. These proportions of sand: silt: clay implies that the soil at the experimental site was predominantly sandy loam. Side dressing method was used to apply fertilizer at the rate of 76 kg N/ha, P_2O_5 30 kg/ha and K_2O 30 kg/ha.

Cassava stem cuttings of 23 cm average length were planted in June, 2014 and 2015 at one stem cutting per stand at 1 m x 1 m spacing giving a population of 10 000 cassava plants /ha. The three middle rows in between the four cassava rows per plot were used to establish the maize stands at the same time resulting in 40 000 maize plants/ ha. Apron plus was used for seed dressing against fungi and insect at the rate of one sachet of apron plus/ kg of maize seeds before sowing. Four maize seeds were sown per stand and thinned to two seedlings per stand twelve days after sowing.

Data collection procedures

Net plot for the cassava sample was 4 m^2 covering the four cassava stands at the central part of each plot, the net plot for the maize sample was 2.5 m^2, this was the space occupied by the five inner maize stands of the middle row in each plot.

The following observations were recorded: weed control rating which was taken at four, seven and ten weeks after sowing through visual estimation on a '0' to '100' scale, '0' meaning no weed control and '100' meaning complete weed control. At maize maturity, maize plants were harvested from the net plots, stems of the plants were cut at ground level, and all the materials were oven dried to constant weight at 70 ℃ and their weights recorded, the cub cover was not included in the stem weight. Similarly, cassava harvesting took place in June of the subsequent year after twelve months in the net plot and was separated into the fresh roots, stems and leaf; the fresh root weight of cassava was taken and recorded while the leaf and stems were oven dried to constant weight at 70 ℃ and weights recorded.

At time of harvesting cassava, twelve months after planting, weeds were collected by harvesting the above ground portion of all weeds within a 25 cm x 25 cm quadrat randomly placed in two locations per plot; the weeds were oven dried to constant weight.

Data Analysis

Data concerning weed control rating were transformed using √ x+0.5 as square root scale and analysed according to Little and Hills (1978) [6]. Data collected were subjected to analysis of variance and means separated using Duncan's Multiple Range Test at 5 % level of probability.

Results

Soils characteristics at the experimental site

Particle size distribution and chemical characteristics of the soils at the experimental site before the commencement of the study are presented in Table 1. The soil had pH value of 5.6, and Wafua (2021) [16] reported that soil pH of 5.5 - 7.3 is the best for maize crops with the optimal being pH 6.0–6.5. The soil pH was therefore suitable for maize production. Total N was 0.9 g kg^{-1}, while the value of available P was 14 mg kg^{-1} and K was 0.32 c mol kg^{-1}. The test values indicated that the soil was low in N, slightly low in P. The soil had Mg value of 1.28 mg kg^{-1}. The soil had 8+16 g kg^{-1} of sand, 71 g kg^{-1} of silt and 113 g kg^{-1} of clay. These proportions of sand: silt: clay implies that the soil at the experimental site was predominantly sandy loam. Soil of this location has similarly been characterized as sandy loam with low nitrogen and organic matter by Ojobor *et al.* (2017) [13].

Weed control rating between four and ten weeks after sowing

Results of Weed Control Rating (WCR) which was observed in the plots from four to ten weeks after sowing are shown in Table 2 and Figure 1. The highest WCR was observed in plots used as weed free check, while the least WCR was observed in plots used as weedy check (Table 2).

At four weeks after sowing, the three hoe-weeding treatments had similar WCR in the two cropping seasons and they ranged from 91.7 to 96.7 % in the two cropping seasons (Table 2).

Among the hoe-weeding treatments, the least WCR of 45.2 % in the plots, was observed at ten weeks after sowing in plots weeded only once in the year 2015, while the highest WCR of 100% was observe in plots hoe-weeded three times at 7 weeks after sowing in 2014 and at ten weeks after sowing in 2014 and 2015 cropping seasons. In the year 2014, the least WCR of 45.0 % in plots weeded two times at ten weeks after sowing was significantly less than 100.0 % in the plots weeded three times, in that same cropping season (2014), similar trend was observed in 2015.

At seven weeks after sowing, the plots which received only one hoe-weeding in 2015 had significantly less WCR of 60 %

compared with any other hoe weeded plots in 2015 cropping seasons; all the other hoe weeding treatments had similar WCR. In 2015, plots that received two hoe-weeding had greater WCR than the ones that received only one hoe-weeding in 2015 at seven weeks after sowing. The plots that received three hoe-weeding had greater WCR than the ones that received one hoe-weeding at 10 weeks after sowing 2014 and in 2015 at ten weeks after sowing.

On the average, weed control rating was similar for the three treatments at 4 weeks after sowing; it ranged from 94.2 to 95.8 % (Figure 1). At seven WAS, plots that received two and three hoe weeding had similar WCR of 88.3 and 97.5 %, respectively, and were greater than 68.3 % WCR in plots that were weeded once; at 10 WAS, it was only plots hoe-weeded three times that had superior WCR to the ones that had less levels of hoe-weeding.

Weed dry weight at time of harvesting of cassava root tubers

There was significant difference in weed biomass at cassava root tuber harvest (Table 3). Each of the hoe-weeding treatments had less weed biomass than the weedy control in 2014 cropping season. In the same 2014, plots weeded twice and three times had similar weed biomass which were 1.3 and 1.1 t/ha, respectively and they were significantly less than 7.8 t/ha observed in plots that received single hoe-weeding. In 2015, plots hoe-weeded once and weedy check had similar weed biomass which were 5.2 and 6.8 t/ha, respectively. In 2015, plots that received two and three hoe-weeding had significantly less weed biomass than both weedy control plots and the plots that received one weeding treatment. In 2015, the plots that received single hoe-weeding had 5.2 t/ha of weed dry weight which was not significantly less than 6.8 t/ha observed in the weedy control.

On the average, weed free plots had less weed biomass than any of the hoe-weeding treatments and the weedy check (Figure 1a). The hoe-weeded treatments at time of cassava root tuber harvest, had weed biomass which ranged from 1.6 to 4.5 t/ha, these were significantly less than 7.3 t/ha observed in the weedy control plots. On the average, the weed biomass were in the order of 7.3 (weedy check) > 4.5 (hoe-weeding once) > 1.8 (hoe-weeding twice) $\geq$ 1.6 t/ha (hoe-weeding once). On the average, weedy check had the highest weed biomass; Kaiira *et al.* (2014) [5] similarly reported that significantly higher weed biomass was observed in the control at harvest.

Maize dry grain yields

There was significant difference in maize dry grain yields among the various levels of hoe-weeding in the 2014 cropping season, the highest in that year was 3.0 t/ha from plots hoe-weeded three times and was similar to 3.1 t/ha obtained from the weed free control; all the other treatments and the weedy control had yields which ranged 2.0 – 2.6 t/ha (Table 4).

Plots hoe-weeded three times had greater dry maize grain yields than the ones that received less number of hoe-weeding in 2014. In the 2015 cropping season, all treatments and the controls had similar dry maize grain yields which ranged 2.6 – 3.0 t/ha; similar trend was observed in the average grain yields which ranged 2.3 – 3.0 t/ha (Figure 1b).

Cassava fresh tuber yields

Significant difference in cassava fresh tuber yields was observed in plots subjected to various levels of hoe-weeding treatments in cassava maize intercrop (Table 3 and Figure 1 c). Cassava fresh tuber yields were in the range of 4.9 (weedy check) – 44.8 (weed free) t/ha in 2014 cropping season and 6.9 (hoe weeded once) – 24.5 (weed free) t/ha in 2015 cropping season. It was observed that plots hoe-weeded once had similar yields with their respective un-weeded control plots in 2014 and in 2015 cropping seasons. Hoe-weeding at three and six weeks resulted in significantly greater yield than the ones that received only one hoe weeding in 2014 cropping season, it was more than 100 % increase.

In terms of the average yield of cassava fresh tubers, weeding only once is like not weeding at all, because there was no significant difference in the cassava fresh tuber yield in the un-weeded control of 6.2 t/ha compared to the yield from plots weeded once at (9.7 t/ha) (Figure 1 c). Additional weeding at six weeks after sowing significantly improved cassava tuber yields to 18.9 t/ha, an increase of about 200 % relative to yields from plots hoe-weeded once. Three hoe weeding, that is, the weeding at 3, 6 and 9 weeks after sowing further improved cassava fresh tuber yields to 24.7 t/ha relative to the yield from the plots hoe-weeded once, an increase of 150 % (Figure 1 c).

Table 1: Pre-cropping particle size distribution and chemical characteristics of the soil at the experimental site

Parameter	Value
pH (H_2O)	5.6
Total Nitrogen (g kg^{-1})	0.9
Available P (mg kg^{-1})	14.0
Exchangeable Ca (c mol kg^{-1})	1.46
Exchangeable Mg (c mol kg^{-1})	1.28
Exchangeable Na (c mol kg^{-1})	0.44
Exchangeable K (c mol kg^{-1})	0.32
Particle size (g kg^{-1})	
Sand	816
Silt	71
Clay	113
Textural class	Sandy loam

Table 2: Effects of level of hoe-weeding on weed control rating in maize and cassava mixture

Level of hoe-weeding	Weed Control Rating (%)		
	4WAS	7 WAS	10 WAS
2014			
HW 3 WAS	91.7 a	76.7 b	45.3 b
HW 3 & 6 WAS	93.3 a	80.0 a	45.0 b
HW 3, 6 & 9 WAS	95.0 a	100.0 a	100.0 a
WEEDY	0.0 b	0.0 c	0.0 c
WEED FREE	100.0 a	100.0 a	100.0 a
SE ±	3.49603	9.88826	3.47051
2015			

HW 3 WAS	96.7 a	60.0 b	45.0 b
HW 3 & 6 WAS	93.3 a	96.7 a	47.3 b
HW 3, 6 & 9 WAS	96.7 a	95.0 a	100.0 a
WEEDY	0.0 b	0.0 c	0.0 c
WEED FREE	100.0 a	100.0 a	100.0 a
SE ±	3.16228	2.78887	2.04396
Average			
HW 3 WAS	94.3 a	68.3 b	45.2 b
HW 3 & 6 WAS	93.3 a	88.3 a	46.2 b
HW 3, 6 & 9 WAS	95.8 a	97.5 a	100.0 a
WEEDY	0.0 b	0.0 c	0.0 c
WEED FREE	100.0 a	100.0 a	100.0 a
SE ±	2.73861	5.29675	2.68121

HW= Hoe- weeding, WAS = Weeks After Sowing

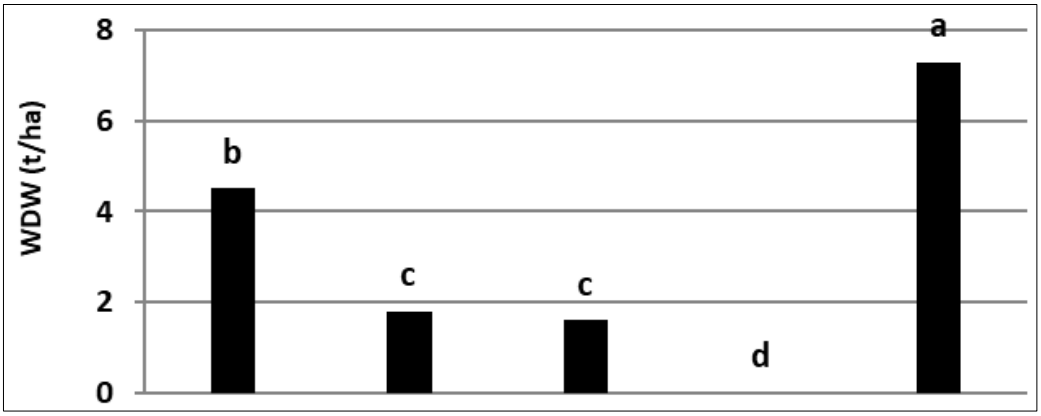
Means in a column with the same letter(s) in the same year do not differ significantly at 5% level of probability using DMRT.

Table 3: Effects of level of hoe-weeding weed dry weight, maize dry grain yield and fresh cassava tuber yield at cassava harvest

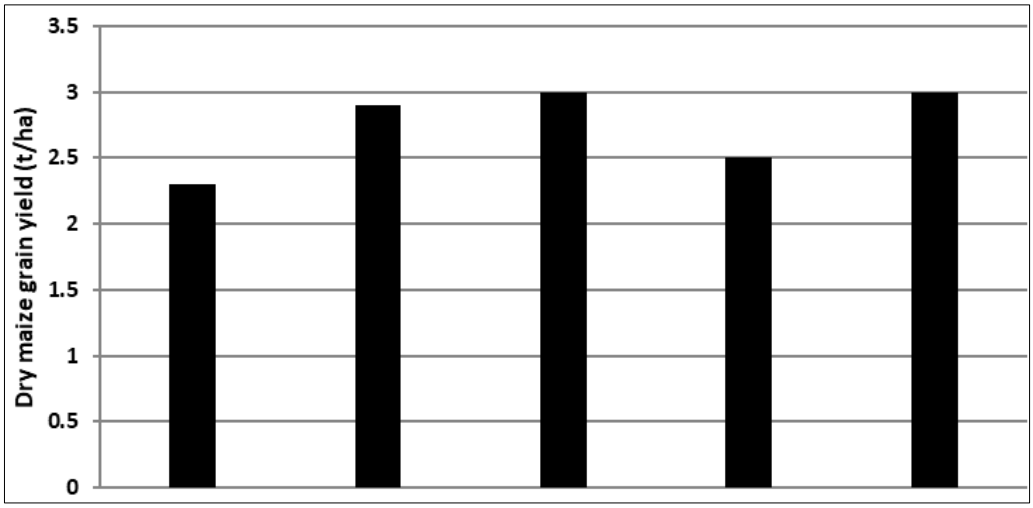
Level of hoe-weeding	Weed dry weight (t/ha)	Maize dry grain (t/ha)	Fresh cassava tuber (t/ha)
2014			
HW 3 WAS	3.7 b	2.0 b	12.4 c
HW 3 & 6 WAS	1.3 bc	2.6 ab	27.9 b
HW 3, 6& 9 WAS	1.1 bc	3.0 a	29.8 b
WEEDY	7.8 a	2.3 b	4.9 c
WEED FREE	0.0 c	3.1 a	44.8 a
SE ±	1.11774	0.35340	3.82163
2015			
HW 3 WAS	5.2 a	2.6	6.9 c
HW 3 & 6 WAS	2.2 b	3.0	10.0 c
HW 3,6 & 9 WAS	2.1 b	2.9	19.5 b
WEEDY	6.8 a	2.6	7.5 c
WEED FREE	0.0 c	2.8	24.5 a
SE ±	0.88894	Ns	1.80407

HW= Hoe- weeding, WAS = Weeks After Sowing

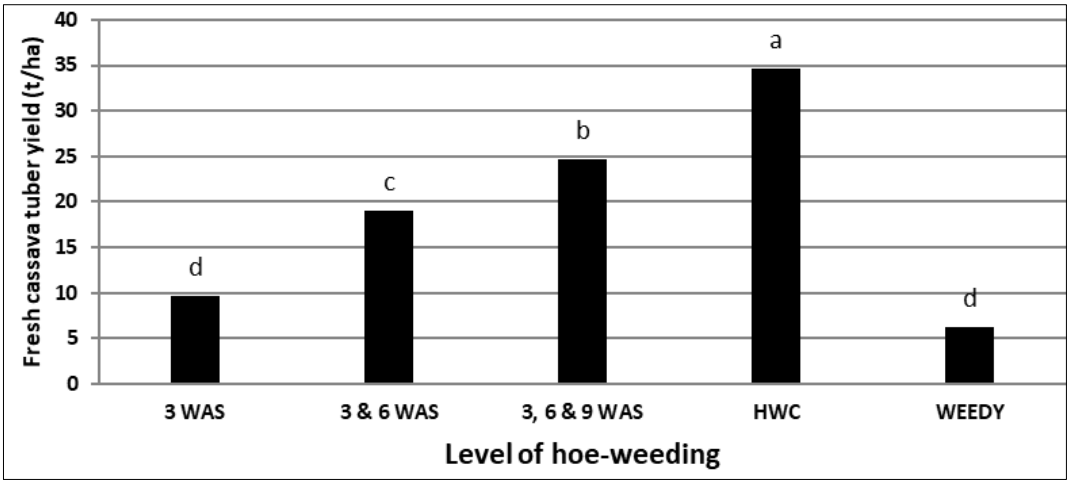
Means in a column with the same letter(s) in the same year do not differ significantly at 5% level of probability using DMRT.



(a)



(b)



(c)

Fig 1: Effects of level of hoe-weeding on weed dry weight (*a*), maize dry grain yield (*b*) and fresh cassava tuber yield (*c*)
WDW = Weed Dry Weight
Note: Bars with similar letter(s) are not significantly different at 5% level of probability.

Discussion

Maize that received single hoe-weeding did not produce better yield than the yield from weedy check, this may be due to the ploughing which was done before the set-up of the experiment, this would have made maize to have a better head start in the weedy check which eventually resulted in yield similar to treatment that received one hoe-weeding. Plots that received hoe-weeding twice and three times had similar maize dry grain yields implying that hoe-weeding beyond six weeks after sowing was not necessary for the variety of maize sown in this environment.

Hoe-weeding at any level had significant improvement over weedy check in the production of cassava fresh tuber roots, hoe-weeding once had more than 100 % increase in yield over weedy check. Each additional hoe-weeding improved the fresh root yields of cassava until hoe-weeding was done three times, beyond three hoe-weeding there was no significant increase in cassava fresh root yield. Phanthasin *et al*. (2016) [7] similarly observed significant increase in cassava root yield due to increase in weeding times, there was high yield of cassava root with three times weeding. Cassava may not need hoe-weeding beyond three properly timed hoe-weeding because before the effect of the third hoe-weeding wears off, cassava plants would have started forming closed canopy which would cut off sunlight that prevents the thriving of surviving weeds under cassava closed canopy.

Conclusion

One or two hoe-weeding was sufficient for suitable yield of maize, while the third weeding at nine weeks growth stage was more beneficial for cassava productivity than for maize in the intercrop. In a cassava maize mixture, the yields of the two crops are fitting, therefore, three hoe-weeding is recommended for significant yield of cassava in the mixture.

Competing Interests

There is no competing interest.

References

1. Agahiu AE, Udensi UE, Tarawali G, Okoye BC, Ogbuji RO, Baiyeri KP. Assessment of weed management strategies and intercrop combinations on cassava yield in the middle belt of Nigeria. African Journal of Agricultural Research, 2011; 6(26):5729-5735. Available online at http://www.academicjournals.org/AJAR, DOI: 10.5897/AJAR11.428
2. Alibi BS, Ayeni AO, Agboola AA. Effect of selected herbicides on the control of thorny mimosa in cassava. Nigerian Journal of Weed Science, 1999; 12:51-57.
3. Amadi G, Ezeh CI. Gender roles in cassava processing in Imo State, Nigeria. Journal of Agriculture and Food Environment, 2018; 5(3):80-92.
4. Ayeni AO, Duke WB, Akobundu IO. Weed interference in maize, cowpea and maize/ cowpea intercrop in a sub-humid Tropical Environment. 1. Influence of cropping season. Weed Research, 1984; 24:269-279.
5. Kaiira M, Kagoda F, Gidoi R. Exploring cost-effective maize integrated weed management approaches under intensive farming systems. Uganda Journal of Agricultural Sciences, 2014; 15(2):191-198.
6. Little TM, Hills JF. Agricultural experimentation: design and analysis. New York: John Wiley and Sons, 1978, p368.
7. Phanthasin K, Saythong O, Amphay S, Naruo M. Effect of weed biomass on cassava yield related to weeding times. Advances in Plants and Agriculture Research, 2016; 5(5):630-632. DOI: 10.15406/apar.2016.05.00194
8. Melifonwu AA. Weeds and their control in cassava. African Crop Science Journal, 1994; 2:519-530.
9. Mehta DC, Dias FF. Maize: Perspectives and applications in India. Starch – Stärke, 1999; 51:52–57.10.1002
10. Milind P, Isha D. Zea maize: A modern craze. International Research Journal of Pharmacy, 2013; 4:39-43.
11. Obiazi CC. Cassava production and utilization: Problems and prospects. Abraka Journal of Agriculture, 1991; 1:111-121.
12. Obiazi CC. Food and feed potentials of cassava: the challenges of the prussic acid in their tubers. Journal of Agriculture and Food Environment, 2018; 5(3):69-79.
13. Ojobor SA, Obiazi CC, Egbuchua CN. Effects of different levels of compost manure on upland rice and soil chemical

properties in Asaba, Delta State, Nigeria. Global Journal of Agricultural Research, 2017; 5(1):25-35.
14. Onwueme IC, Sinha TD. Field Crop Production in Tropical Africa: Principles and Practices. CTA Wageningen, Netherlands, 1991.
15. Shrestha J, Timsina KP, Subedi S, Pokhrel D, Chaudhary A. Sustainable Weed Management in Maize (Zea mays L.) Production: A Review in Perspective of Southern Asia. Turkish Journal of Weed Science, 2019; 22(1):133-143. www.iosrjournals.org
16. Wafua V. Growing maize in an acidic soil environment. Yara East Africa Region, 2021. https://www.yara.co.ke/crop-nutrition/agronomy-advice/growing-maize-in-an-acidic-soil-environment/#:~:text=In%20general%2C%20Maize%20as%20a,negatively%20affect%20availability%20of%20Nutirents. Accessed 13 June 2022