Early and Late-Season Maize Landraces Performance on Selected Weed Control Practices

Uko, I.[1], Ngonadi, E.N.[2] and Ikenwa, B.O.[1]*

1 Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria
2 Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Nigeria

KEYWORDS

Early Maize production,
Late-Season Maize production,
Weed control method.

ABSTRACT

This experiment was conducted in 2021 and 2022 cropping season at the Teaching and Research Farm of Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, to assess the performance of selected weed control methods under rain fed maize production in three different successive months. This study was laid out as a 3x4 factorial experiment in randomized complete block design (RCBD) with three replications. The selected cultivars was the main factors (Oka Bende, Oka Abakaliki and Oka Nsukka) while the four weed control method (Check [No weeding], Hoe weeding, Pre-emergence and post emergence) consisted of the sub-factor. The selected maize landraces responded positively to the weed control methods especially 'Oka Nsukka' and 'Oka Bende' in both seasons and adapted easily in Igbariam. Oka Nsukka, in the early season, gave the best grain weight per 100 seeds followed by Oka Bende while Oka Abakaliki had the best grain yield in the late season planting. The results obtained indicated that, a combination of pre-emergence herbicide and hoe weeding at 6WAS ensured that the weeds are adequately controlled and yield maximized.

*CORRESPONDING AUTHOR

i.uko@unizik.edu.ng

INTRODUCTION

Maize (*Zea mays*) is regarded as one of the most important cereal in the world after wheat and rice with regard to cultivation area and level of production. In Africa, maize is also the second important food crop after rice (FAOSTAT, 2014). It is capable of producing well under appropriate season in most parts of the world where farming it is cultivated (Akande and Lamidi, 2006). It is used as human food, ruminant and poultry feed and industrial products (Bibi *et al*., 2010). It contributes about 6.4% to the total grain production in Nigeria and occupies an important position in the national economy; as it is a good source of food for people, feed for poultry and folder for livestock. About 7.0 million metric tons was produced in 2003 from 3.2 hectares and has risen to 11.6 million tons (MMT) in 2021/2022 (USDA, 2022). Maize cultivation in Nigeria also done in combination with other crops (mixed cropping) to give it comfortable advantages over most other food crops. The consumption pattern of maize varies in Nigeria among the states, but maize is generally consumed as green maize, breakfast cereals, baby food, and the different types of preparation for local dishes (FAOSTAT, 2011).

However, out of the three major developing region of the world, Africa is the only one in which the index of per capital food production has decrease steadily during the last two decades. As a result this circumstance, the spectra of hunger and malnutrition is perpetually hanging over the countries of the continent where an estimated 35 percent of the population, some 140 million people, largely children and women suffer from hunger and malnutrition (CSA, 2010). Furthermore, the full potential of this very important crop is yet to be attained; especially among the local farmers due to a number of factors ranging from insect pests, climate change, and more especially an effective and efficient weed control methods.

Weed control is major contributor to the labour input for the production of maize crop in Africa. Weeds are one of the major problems in crops and maize production around the world. Weeds compete with crops for nutrients, water, light and space (Bogatek *et al*., 2006). Weeds also differ in their competitive abilities which vary according to conditions and the time of year. Weed management is, therefore, a major concern in any agricultural system. The competition between weeds and maize at critical growth stages has the capacity to reduce both the quality and quantity of maize yield by over 30% (Mahmood and Ali, 2009, Ahmed *et al.,* 2014). For controlling weeds in crop fields, farmers are generally adopting mechanical, cultural, biological and chemical control methods. According to Ahmed *et al.* (2015), using physical weed control methods as tedious, time consuming and exhaustive, thus, farmers tends to move toward other alternative methods due to labour crisis during critical period of weed control in crops. While, the mechanical methods are still useful but are unable to effectively control weeds successfully due to the absence of right machinery especially on small and medium scale level (Chikoye *et al.,* 2007). According to Ahmed *et al.* (2008), the judicious and right use of a different combination of herbicides as pre-plant, pre-emergence and post-emergence can provide effective and efficient weed control. Chikoye *et al.* (2005) earlier reported that chemical weed control may be cost-effective, faster and better weed control method. Managing weed populations through modification of the cropping pattern has been reported to be component of integrated weed management (IWM) in maize a number of cultural practices including alteration in population density (Nurse and Di Tommaso, 2005) and planting dates (William, 2006), row spacing, maize leaf orientation (Norsworthy and Oliveira, 2004), etc. have been studied with the aim of improving the crop's ability to establish dominance over weeds, thereby enduring competitive stress caused by the weeds. However, in the last decade, crop modeling has been used to determine optimal planting dates for maize in the temperate regions (Anapalli *et al.,* 2006). Only very few of such studies have been conducted in tropical African countries, despite the fact that maize is one of the most important cereal crops in the continent. Keeping these challenges in view, this experiment seeks to know the response of maize landraces/cultivars common in the South Eastern Nigeria to various weed management practices and to assess the most efficient of different weed management control methods in the growth and yield parameters of maize production in both early and late-season plantings.

MATERIALS AND METHODS

Experimental Site: The field experiment was carried out during 2022 cropping season. at Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, Anambra State. It is located in the tropical rain forest zone of South-eastern Nigeria at latitude 6^0 26' N and longitude 6^0 94' E. The soil of the area is characterized by deep porous soil derived from sandy deposits in the coastal plains which are highly weathered, low in mineral reserve and natural fertility. The area is also characterized by minimum and maximum temperatures of between 30^0C and 45^0C respectively.

Experimental Design: The experiment was 3x4 factorial combination laid out in a randomized complete block design (RCBD) and was replicated three (3) times. Three cultivars was main factor while four (4) weed management practice was sub-factor constituted (12) treatment combinations with an inter row spacing distance of 0.75m and intra row spacing of 0.25m with 3m long ridges. Total experimental plots were 36 plots.

Land preparation: The experimental site measuring 14m×14m was marked out. The field was manually cleared and packed using cutlass, spade, rake and tilled very well and prepared into fine tilt. The planting was done on ridges.

Sowing: Maize was planted on 22nd April, 2022 representing the early season planting while the late season planting was done 26th August, 2022, at an inter row spacing of 0.75m and intra row spacing of 0.25m within the row of 3m long. Two seeds were sown per hole at 5cm depth.

Weeding: Four different weeding strategies was applied. Check (No weeding) (W0), physical method with hoe weeding (twice) at 3 and 6 weeks after sowing (WAS) (W1), chemical method with pre-emergence herbicide (Atrazine 3ml/L of water per plot) was applied immediately after sowing followed by hoe weeding at 6 WAS (W2) and post emergence herbicide (Nicosulphuron 3ml/L per plot) using a knapsack sprayer at 3weeks after sowing (W3) to manage weeds on experimental field.

Fertilizer Application: The application of N:P:K (15:15:15) fertilizer at the rate of 100 kg/ha was done to ensure an effective utilization at 4 and 7 weeks after sowing (WAS) (Balasubramanian *et al*., 2008).

Source of Sowing Materials: The seed of three (3) different maize cultivar used were sourced from ADP, Ministry of Agriculture Anambra, Abia and Ebonyi State in South- Eastern Nigeria. The seeds viability was also tested.

Date Collection: Data was collected on the following:

Plant height: this was done at tasseling. Three maize plants were randomly selected from each plot as a representative sample. The measurement was taken from the base of the plant to the last leaf with the help of measuring tape (cm).

Stem girth: this is achieved by measuring the girth with thread, which is placed on calibrated rule in cm for the actual value.

Leaf area: This was determined by measuring the length and breadth of the leaf with measuring tape and then multiplied it with a constant (0.75) as recommended by Musa and Usman (2016). The leaf length was measured from the base of the leaf to the tip while the breath of the leaf was measured across the base.

Number of Cobs: this is the number of maize cobs per plant. This was obtained by counting the number of cobs on each plant stand.

Cobs fresh weight: this is the total fresh weight of harvested cob per plot measured in (kg). This was obtained by harvesting the entire fresh cob in each plot and weight it using weighing balance.

Cobs at dry weight: this is the total dry weight of the harvested cob per plot after sun drying it in (kg).

Grain weight/100 seeds (%): is determined by counting out hundred pieces of the maize grains from the cob of each plot and weight it on digital weighing balance in (g).

Weed density and weed biomass: Data on weed density and biomass was collected from several laying of 50cm x 50cm quadrat ten times across a diagonally transect on the experimental plot. Weed sample was collected and counted separated according to their species (Akobundu *et al*., 2016).

Statistical Analysis: All data collected was subjected to analysis of variance (ANOVA) using Gen-stat release 10.3 statistical software. The means was separated using Fisher's Least significant difference (F-LSD) at 5% probability level.

RESULTS

Soil properties of the experimental site

In order to ascertain the physical and chemical properties of the soil at the experimental site, the soil analysis was carried (Table 1). The result obtained showed that the soil textural class was sandy clay loam. The soil pH was 5.98. The values for nitrogen, phosphorus and potassium which the elements mostly leached are 0.055 (%), 3.89 ($mgkg^{-1}$), and 0.26 ($cmolkg^{-1}$) respectively.

Weed flora composition

Pre-weed sampling was also done to know the weed flora composition of the study site (Table 2). The sampling showed that a total of ten (10) weed species belonging to eight (8) families existed in that location. The result indicated that *Sida acuta* followed by *Cynodon dactylon* and *Calapogonium mucunoides* dominated the experimental sites.

Effect of maize landraces and weed control methods on maize growth parameters at 4 and 8 weeks after sowing (WAS) in the early and late-season planting

Table 1: Physical and chemical properties of soil at the experimental site taken at 0–15cm depth

Parameters	Value
Clay	230 (g/kg)
Silt	210 (g/kg)
Fine sand	420 (g/kg)
Coarse sand	160 (g/kg)
Textural class	Sandy clay loam
Bulk Density	1.39gm-3
Total porosity	48.92 (%)
Moisture Content	20.52 (%)
Dispersion Ratio	0.87 (%)
Aggregate Stability	17.02 (%)
Hydraulic conductivity	4.59 (cmhr-1)
pH (H2O 1:1)	5.98
Oxygen Content	0.76 (%)
Nitrogen	0.055 (%)
Available Phosphorus	3.89 (mgkg-1)
Calcium (Ca2+)	1.5 (cmolkg-1)
Magnesium (Mg2+)	1.3 (cmolkg-1)
Sodium (Na+)	0.24 (cmolkg-1)
Potassium (K+)	0.26 (cmolkg-1)
Exchangeable Cation Exchange Capacity (ECEC)	4.99 (cmolkg-1)
Base Saturation	87 (%)

Source: Agricultural Development Programme (ADP) Soil Laboratory Unit.

Table 2: Pre-weed species density and frequency percentage at the experimental site.

S/No.	Species	Family	Total	%/Frequency
1	*Digiteria abyssinica*	Poaceae	11	9.65
2	*Cynodon dactyion*	Poaceae	13	11.40
3	*Calandem bicolor*	Araceae	7	6.14
4	*Phyllaninus urinaria*	Phyllanthaceae	12	10.53
5	*Chromolaena odorata*	Asteraceae	11	9.65
6	*Calapogonium mucunoides*	Fabaceae	13	11.40
7	*Sida acuta*	Malvaceae	15	13.16
8	Asystasia gangetica	Acantheceae	11	9.65
9	*Alternathera brasilliana*	Amaranthecae	9	7.89
10	*Axonopus compressus*	Poaceae	12	10.53
		Total	114	100

Plant height: The height of maize did not significantly differ among the cultivars in both early and late-season cropping period, but weed control methods had significant effect on maize height in both seasons at 4 and 8WAS (Table 3). The interaction between maize variety and weed control methods had not significant effect on maize height in both seasons as well at 4 and 8WAS. In the early-season at 8WAS, Oka Bende (195.30cm) was taller than the rest while Oka Abakaliki (202.00cm) in the late-season at 8WAS produced the tallest plants.

Under the weed control methods used, maize varieties in plots treated with pre-emergence herbicide (+ hoe weeding at 6WAS) gave the tallest plants in the early-season at 4 and 8WAS. Similar trend was also observed in the late-season.

Stem girth: Maize varieties stem girth differed significantly at 4WAS in both seasons whereas, at 8WAS it did not (Table 3). The result also indicated that the weed control methods significantly affected the stem girths of maize plants while the interaction effect was not significant in both seasons at 4 and 8WAS. Oka Nsukka gave the biggest stem girth in the early-season while Oka Bende had the biggest stem girth in the late-season although it was not significantly different from the other varieties. The result also indicated that maize stem girth was biggest in plots treated with pre-emergence herbicides (+ hoe weeding at 6WAS) in both seasons compared to the other weed control methods.

Table 3: Effect of maize landraces and weed control methods on maize height, girth and leaf area at 4 and 8 weeks after sowing (WAS) in 2022 cropping season at Igbariam.

	Early Season						**Late season**					
	Height (cm)		**Stem girth (mm)**		**Leaf area (cm^2)**		**Height (cm)**		**Stem girth (mm)**		**Leaf area (cm^2)**	
Treatment	**4WAS**	**8WAS**	**4WAS**	**8WAS**	**4WAS**	**8WAS**	**4WAS**	**8WAS**	**4WAS**	**8WAS**	**4WAS**	**8WAS**
Variety (Var.)												
Oka Abakaliki	65.80	194.70	3.50	8.25	389.80	782.60	63.00	202.00	4.16	8.30	377.80	613.0
Oka Bende	64.00	195.30	4.17	7.92	377.80	783.70	65.30	200.00	3.91	9.30	389.80	637.0
Oka Nsukka	63.20	190.20	3.92	8.33	389.80	790.70	62.20	201.00	3.50	9.00	389.80	643.0
Mean	64.33	193.40	3.86	8.16	385.80	785.66	63.50	201.00	3.85	8.80	385.80	631.0
LSD	NS	NS	0.50	NS	NS	NS	NS	NS	0.48	NS	NS	NS
Weed Control Method (WCM)												
W0	46.90	95.60	2.22	6.33	346.90	715.20	46.40	106.00	2.22	6.20	346.90	540.0
W1	62.30	205.10	2.89	7.89	388.80	765.10	52.30	208.00	2.88	8.30	388.80	564.0
W2	88.00	241.00	5.78	10.00	415.70	851.10	80.60	244.00	5.77	9.60	415.70	717.0
W3	60.00	232.00	4.56	8.44	391.70	811.1	58.60	214.00	4.55	8.00	391.70	590.0
Mean	64.30	193.42	3.86	8.16	385.77	785.62	59.20	193.00	3.85	8.00	385.77	602.0
LSD	6.87	13.18	0.58	0.60	19.53	19.89	8.90	19.60	0.55	3.10	19.81	NS
Interaction Var. x WCM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significant, W0 = Weedy check, W1 = Hoe weeding (at 3 and 6 WAS - weeded control), W2 = Pre-emergence herbicide application + hoe weeding at 6 WAS, W3 = Application of post-emergence herbicide at 3 WAS.

Leaf area: The leaf area among the maize varieties did not differ significantly at 4 and 8WAS in both seasons (Table 3). The result obtained also showed that the weed control methods significantly affected the maize leaf area at 4 and 8WAS in both seasons whereas, the interaction had no significant difference at 4 and 8WAS in both seasons. It was observed that leaf area was highest in plots treated with pre-emergence herbicides (+ hoe weeding at 6WAS) in both seasons.

Effect of maize landraces and weed control methods on maize yield parameters at harvest in the early and late-season planting

Harvested cobs: There was no significant difference in the number of harvested cobs among the different maize varieties in both seasons (Table 4). The number of cobs was only significant in the early season planting with the number of harvested cobs highest in plots treated with pre-emergence and hoe weeded at 6WAS. The interaction effect did not significantly affect the number of harvested maize cobs.

Weight of harvested cobs: The weight of harvested cobs of maize followed similar trend as the number of harvested cobs with regards to the varieties, weed control methods and the interaction effect.

Dehusked cob weight: Dehusked cob weight was significantly different in the late season planting alone while the weed control methods significantly affected the weight of dehusked cobs in both seasons (Table 4). The interaction effect of maize variety and weed control methods was also significant at late season planting alone. In the late-season, Oka Bende gave the heaviest cob weight followed by Oka Nsukka. Maize varieties sown in plots treated with pre-emergence herbicide and hoe weeded at 6 WAS produced the highest dehusked maize cob weight in both seasons.

Grain weight/100 seeds: Oka Nsukka in the early season planting had the highest percentage grain weight per 100 seeds of maize (Table 4). In the late-season planting, it was not significant. Maize varieties in the plots treated with pre-emergence herbicide and hoe weeded at 6WAS, followed by plots where post-emergence herbicides were applied at 3WAS, significantly gave the highest grain weight per 100 seeds in both seasons. However, the interaction effect did not significantly have any effect on the maize grain weight per 100 seeds.

Table 4: Effect of maize landraces and weed control methods on maize number of harvested cobs, weight of harvested cobs, weight of dehusked cob and grain weight/100 seeds of selected maize varieties in 2022 cropping season at Igbariam.

	Number of harvested cobs		Weight of harvested cobs (Kg)		Dehusked cob weight (kg)		Grain weight/ 100 seeds (%)	
Treatment	Early	Late	Early	Late	Early	Late	Early	Late
Variety (Var.)								
Oka Abakaliki	31.67	21.89	1.73	1.40	0.48	0.45	12.52	9.00
Oka Bende	31.67	22.61	1.77	1.00	0.48	0.52	13.61	8.30
Oka Nsukka	31.83	22.61	1.64	1.70	0.44	0.47	14.04	9.20
Mean	31.72	22.37	1.71	1.30	0.46	0.48	13.39	8.80
LSD	NS	NS	NS	NS	NS	0.04	1.21	NS
WCM								
W0	19.22	21.96	1.22	1.20	0.21	0.22	7.81	6.80
W1	31.89	22.33	1.70	1.00	0.38	0.42	10.89	8.30
W2	40.67	22.63	2.17	1.10	0.74	0.73	19.36	8.60
W3	35.11	22.56	1.76	1.10	0.53	0.55	15.50	8.90
Mean	31.72	22.37	1.71	1.10	0.46	0.48	13.39	8.20
LSD	3.88	NS	0.16	NS	0.07	0.05	1.40	5.60
N Interaction								
S Var. x WCM	NS	NS	NS	NS	NS	*	NS	NS

= Not significant, * = Significant at 0.05%, W0 = Weedy check, W1 = Hoe weeding (at 3 and 6 WAS - weeded control), W2 = Pre-emergence herbicide application + hoe weeding at 6 WAS, W3 = Application of post-emergence herbicide at 3 WAS.

Effect of weed control methods and maize cultivars on weed density and biomass at 8 weeks after sowing (WAS) in both cropping season at Igbariam

Weed density: Weed population was not significantly different in both seasons under the maize varieties at 8WAS (Table 5). But the population of weeds was significantly highest in the weedy checks whereas the interaction between the maize variety and weed control methods showed no significant difference.

Weed biomass: The weed biomass followed similar trend as the weed density (Table 5). In both seasons, the weed biomass was not significantly different under the maize varieties planted although the highest weed biomass was found under Oka Abakiliki in the early season while Oka Bende had the highest weed biomass in the late season planting. The highest weed biomass was however found in the weed check plots which produced significantly very high weed biomass.

Table 5: Effect of weed control methods and maize cultivars on weed density and biomass at 8 weeks after sowing (WAS) in 2022 cropping season at Igbariam

Treatments	Weed density		Weed biomass (g)	
	Early season	Late season	Early season	Late season
Variety (Var.)				
Oka Abakaliki	86.40	56.00	163.10	119.60
Oka Bende	89.20	78.80	157.70	125.10
Oka Nsukka	62.80	67.40	143.20	124.20
Mean	79.46	67.40	154.66	122.20
LSD ($_{0.05}$)	NS	NS	NS	NS
Weed Control Method (WCM)				
W0	221.40	175.70	461.6	327.60
W1	42.80	40.8	64.30	35.10
W2	16.10	27.95	27.40	28.20
W3	37.70	28.20	65.30	30.80
Mean	79.50	68.16	154.65	105.43
LSD ($_{0.05}$)	53.95	22.64	45.28	36.24
Interaction				
Var. x WCM	NS	NS	NS	NS

NS = Not significant, W0 = Weedy check, **W1** = Hoe weeding (at 3 and 6 WAS - weeded control), **W2** = Pre-emergence herbicide application + hoe weeding at 6 WAS, **W3** = Application of post-emergence herbicide at 3 WAS.

DISCUSSION

The physical and chemical properties of the soil of the area are an evidence characterized by deep porous soil which is derived from sandy deposits in the coastal plains. The soils of this area are highly weathered, low in mineral reserve and natural fertility (Chikezie *et al*, 2010). Also, the weed flora composition is a reflection of the diversity of weeds in a tropical environment. The general weed composition of the experimental site followed a similar trend as reported by Melifonwu (1994) who noted that broadleaved weed species are usually the most frequent weeds in Southeast Nigeria. This also corroborated the report of Toure *et al.* (2013) and Olayinka *et al* (2020) in class composition weeds for different zones in Nigeria and Africa. This area was largely occupied by broads and a number of grasses which explains why the application of pre- emergence herbicide followed by hoe weeding at 6 WAS controlled the weeds better resulting in better yield of maize in both seasons. The lack of significant differences in the growth and yield parameters of the various maize landraces measured may be an indication that they adapted easily in the environment irrespective of the season when they are planted (Toloraya *et al.,* 2010). However, with regards to the maize grain weight per 100 seeds, Oka Nsukka gave the best yield especially in the early season planting followed by Oka Bende in the early season and Oka Abakaliki in the late-season plantings.

Among the weed control methods used in this study, application of pre-emergence followed by hoe weeding at 6 weeks after sowing provided the best weed control in both seasons thereby increasing the yield of the maize crops. This showed that using the combinations of herbicides and hoe weeding will constantly keep the maize plot weed free. This is similar to the findings of Mahadi, (2011) as he stated that weed competition decreases growth and yield of maize plant.

CONCLUSION

The result from this research suggested that the selected landrace maize cultivars responded positively to the weed control treatments especially 'Oka Nsukka' and 'Oka Bende' in both seasons thus, should be produced more in their localities. Therefore, a combination of pre-emergence herbicide and hoe weeding will always ensure that the weeds are adequately controlled to maximize yield.

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