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PROFITABILITY OF SELECTED WEED CONTROL METHODS IN MAIZE (*Zea mays* L. Moench) PRODUCTION AT IGBARIAM IN THREE SUCCESSIVE MONTHS

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Abstract

This experiment was conducted in 2021 and 2022 cropping season at the Teaching and Research farm Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State. The aim was to determine the effect of selected weed control methods on sole maize production and their economic profitability in Igbariam, Nigeria. It was a 3x4 factorial combination laid out in randomized complete block design (RCBD) with three replications. The selected cultivars was the main factor (Oka Bende, Oka Abakaliki and Oka Nsukka) while the four weed control methods (weedy check, hoe weeding, pre-emergence and post emergence) represented the sub-factor. Data was collected on germination percentage (5DAS and 8DAS), growth parameter (Plant height, stem girth and leaf area) and economic assessment. Data collected was subjected to data analysis of variance (ANOVA) and significant mean were separated using Fisher's Least Significant Difference. The highest number of percentage seed germination was recorded in Oka Nsukka 92.2% at 5DAS and Oka Bende 99.0% at 8DAS. Application of pre-emergence herbicide gave the plant height (249.0 cm), leaf area and plant girth was highest in Oka Bende. Pre-emergence herbicide indicated to have more superior weed control effect and more profitable than the other weed control methods used in the study.

Keywords: Maize, profitability, methods, weeds, yield

Introduction

Weeds are regarded as one of the major problems in crop production around the world; especially in the tropics, (Ogundale, 2006). They can compete with crops or convert productive land into unusable scrub. They are often poisonous, distasteful and harmful, and consequently interfere with the use and management of desirable plants by significantly reducing crop yield as well as contaminate harvests, (Anikwe et al., 2000, Jeetendra et al., 2023). They compete with crop for space, nutrients, water and light (Ahmed, 2014) and one of the major important crops that cannot compete effectively with weeds is the maize plant.

Maize (Zea mays L.) commonly known as corn is one of the cereal crops which belongs to the grass family, Poaceae. It is one of the most important cereal crops of the world after rice with respect to cultivated area (FAOSTAT, 2014). In Nigeria, about 5.5 million metric tons of maize grain was produced in 1999 from 3.2 million hectares which was estimated to have increased to 7.0 million metric tons in 2003 from 3.2 hectares. But, in 2021/2022, maize production rose to 11.6 million tons (MMT) and it is forecasted to rise up to 12.5 million metric tons in 2022/2023 (USDA, 2022). The phenomenal increase in maize production in Nigeria over the past few years was attributed to improved management practices, multiple utilization of the crop for various food items, livestock feed and industrial materials as well as the drive by the Federal Ministry of Agriculture and Rural Development (FMARD) in Africa (FAOSTAT, 2014, USDA, 2022). However, the full potential of this very important crop cannot be attained; especially among the local small scale farmers without an effective and efficient weed control method.

Hence, weed management is a major concern in modern day agricultural system. Currently, most researchers are particularly concerned with identifying management techniques that could suppress weed without paying attention to economic efficiency of these techniques (Sapkota et al., 2023). In mono-cropping maize, weeds are generally controlled using cultural (hand pulling or hoe weeding), mechanical (slashing), chemical (pre – plant, pre or post – emergence herbicides) and integrated management practices (Hetta et al., 2022). Whereas, chemical control was judged to be expensive, and poor application can cause crop injury, harm to the environment, soil, and even the applicator, while manual weeding was reported damaging to maize root systems (Chikoye et al., 2000, Manisankar et al., 2022) especially now that the exchange rate of dollar to naira in Nigeria is very high. Furthermore, manual weeding is time consuming, laborious and very expensive. For example, hand weeding one hectare of land cropped to maize may require as much as 25-40 person –

days, depending on the weed density and cropping system adopted. This represents approximately 50%-80% of the total labor budget (Chikoye et al., 2002, Imoloame, 2021). Labour is often in short supply during the early stages of crop growth when weeds must be controlled due to high rate of rural-urban migration in southeastern part of Nigeria. Weeds that are allowed to grow to maturity stage demand more time and labor for effective control, and untimely weeding causes significant crop losses (Chikoye et al., 2004).

A decade ago, several researchers have reported that chemical weed control was better alternative to manual weeding if applied at the right rate, dosage and time, is cheaper, faster, and gives better control for controlling weeds in maize (Chikoye et al., 2004, Korieocha, et al., 2011, Reddy et al., 2012). But, due to the free fall of naira against dollar in the recent time, there is need to assess and evaluate it's the profitability of chemical weed control method against manual method in the recent time in the study area.

Materials and Methods

This research was conducted at the Teaching and Research farm Department of Crop Science and Horticulture, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State in 2021 and 2022 cropping seasons. Igbariam lies between latitude 140 65N and longitude 120 35 E. This study was a 3x4 factorial experiment laid out in randomized complete block design (RCBD) with three replications. The main factor consisted of selected maize cultivars (Oka Bende, Oka Abakaliki and Oka Nsukka) while the sub-factor consisted of four weed control methods (Weedy check, Hoe weeding, Pre-emergence and post emergence). The field was manually cleared and tilled well; into fine tilt. The planting was done on ridges. Maize was sown separately in May, June, July 2021 and 2022 cropping seasons with 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. The seed of three (3) different maize cultivars/landraces (Oka Abakiliki, Oka Bende and Oka Nsukka) was sourced from ADP, Ministry of Agriculture, Anambra, Enugu and Ebonyi State in South- Eastern Nigeria.

Data Collection

Emergence percentage: This was determined by the number of days it takes the maize to sprout at after planting ×100/1. It is calculated by the formula below:

$$Emergence\ percentage = \frac{Total\ number\ of\ emerged}{Total\ number\ of\ seeds\ planteed}\ x\ \frac{100}{1}$$

Plant height: This is a measure of tallness of plant in (cm) at 4 and 8 weeks after sowing (WAS). Three maize plants was randomly selected from each plot as a representative sample. The measurement was taken from the base of the plant to the last leaf using measuring tape.

Leaf area: This was determined by measuring the breath and the length 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 at 4 and 8 WAS.

Stem girth: This was achieved by measuring the girth with sowing-thread, which is placed on calibrated rule in cm for the actual value at 4 and 8 WAS.

Grain yield: The grain yield of the maize were collected at harvest and used for economic evaluation of the different weed control methods.

Economic Analysis: Economic evaluation of the different weed control methods was carried out using partial farm budget by (Okoruwa et al., 2005). Prevailing labor and market costs of materials was used to obtain the revenue from grain yield of each treatment.

Revenue= Ym x Pm (where, Ym = maize yield in kilogram/ha; Pm = Price of maize grain.

The profit was calculated by subtracting the costs of production from the sales revenue represented as follows:

Profit (net revenue) = Revenue-Total cost of production

Simple proportion of total cost of weed control (cost of production) and net revenue (profit) was used to determine the cost benefit ratio (CBR) of each of the weed control method as follows:

Benefit Cost ratio (CBR)= Profit (net revenue)/Total cost of production compared to the rest of the treatment.

Data analysis

Data collected was subjected to analysis of variance (ANOVA) using Gen-stat Release 10.3 statistical. While the means were separated using the Fisher's Least Significant Difference (LSD) at 5% probability level.

Results

Effect of variety and weed control methods of maize on germination

Table 1 above showed the result of number of germinated maize seeds at five and eight days after sowing both was not significantly different. Oka Nsukka recorded highest germinated seed at 5DAS 92% in the month of July, 2022 while at 8DAS Oka Bende had the highest value as 99%. The lowest

number of germination percentage was recorded in Oka Abakiliki 86.5% at 5DAS and 96.6% at 8DAS respectively. The weed management practices applied as examined was significantly different in all the months at 5DAS both in 2021 and 2022, with the highest value in pre-emergence herbicide application 95.3% The analysis of variance showed that the interaction between cultivar and weed management practices was not significant.

Effect of variety and weed control methods of maize on plant height

The result on growth parameters; plant height among the cultivars were not significantly different but among the weed control methods applied the result was significantly different (Table 2). On plant height, pre-emergence herbicides recorded the highest value (83.1 cm) in July, 2021 at 4WAS and (249.0) at 8WAS in the month of May 2021. The lowest plant height value was recorded on weedy check plot both at 4WAS and 8WAS (46.4 and 106) respectively. The analysis of variance showed that the interaction between cultivar and weed management practices was not significant.

Effect of variety and weed control methods of maize on plant height

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Table 1: Effect of variety and weed control methods on maize percentage germination (%) in May, June and July at Igbariam in 2021 and 2022 cropping seasons.

	Germination at 5 DAS						Germination at 8 DAS					
	May		June		July		May		June		July	
Treatment	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Variety(Var.)												
V1	86.7	88.1	87.6	89.4	87.7	90.0	98.2	96.4	98.5	97.6	97.8	96.6
V2	90.4	91.0	90.7	90.6	90.8	89.3	97.0	98.0	96.8	98.4	97.4	99.0
V3	90.2	89.6	90.5	91.1	90.4	92.2	96.7	98.1	97.3	98.5	98.0	98.7
Mean	89.1	89.5	89.6	90.3	89.6	90.5	97.3	97.5	97.4	98.1	97.7	98.1
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
WCM												
W0	85.5	86.3	86.5	87.3	85.6	86.4	96.1	97.0	96.1	96.8	96.3	97.2
W1	90.4	89.6	90.2	91.4	90.2	92.3	98.3	98.4	98.3	99.0	98.2	99.2
W2	94.3	94.2	95.3	93.3	95.1	93.6	99.2	98.0	99.2	98.5	99.3	98.6
W3	87.6	88.0	87.5	89.2	87.8	88.6	97.2	97.4	97.2	96.6	97.0	96.7
Mean	89.5	89.6	89.8	90.3	89.7	90.2	97.7	97.7	97.6	97.7	97.6	98.0
$LSD_{0.05}$	5.7	5.8	5.5	5.2	5.5	5.6	ns	ns	ns	ns	ns	ns
Interaction												
Var. x WCM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

NS = Not significan**t, W0** = Weedy check, **W1** = Hoe weeding (weeded control), **W2** = Pre-emergence herbicide application, **W3** = Post-emergence herbicide, **V1**= Oka Abakiliki, **V**2= Oka Bende, **V3** = Oka Nsukka, WCM= Weed control methods.

Effect of variety and weed control methods of maize on plant girth and leaf area (cm^2)

The result on leaf area and stem girth is presented in Table 3. The result obtained indicated that Oka Bende recorded the thickets stem girth (9.7cm) and leaf area (663 cm^2) at 8WAS in the month of June, 2021. Oka Abakaliki recorded the lowest values both on the plant girth (8.1 cm) and leaf area (603 cm^2) at 8WAS respectively. The weed management practices applied as examined was significantly different on the plant girth with the highest value on pre-emergence herbicide (11.6 cm) and lowest in weedy check (6.2 cm). While the highest value for plant leaf area was recorded in pre-emergence as 779 cm^2. The analysis of variance showed that the interaction between cultivar and weed management practices was not significant.

Cost and benefit of selected weed treatment of maize production

The cost and benefit analysis of selected weed control treatment of maize in 2021 and 2022 cropping season shown in Tables 4 and 5. The result obtained showed that the value of the revenue varied from ₦102,865 to ₦461,511 in 2021. The highest revenue was obtained under Atrazine herbicide application ₦461,511.17 followed by two hoe weeding (₦399,542.78) while weedy check has the

lowest revenue (₦102,865.00) which obviously is as a result of heavy weed infestation in 2021. The highest grain yield (3,140.60kg/ha) was obtained in Atrazine while the lowest grain yield (700kg/ha) was seen in the weedy check. Atrazine also recorded the highest net revenue (454,011.17) followed by Two Hoe weeding (355,542.78).

In 2022, the value of the revenue varied from ₦117,560.00 to ₦462,980.70. The highest revenue was recorded under Atrazine herbicide application followed by two hoe weeding ₦399,542.78 while weedy check has the lowest revenue which obviously is as a result of heavy weed infestation in the cropping season. The highest grain yield (3,150.60kg/ha) was recorded under Atrazine while the lowest was recorded in the weedy check 800kg/ha. Atrazine also recorded the highest net revenue (454,980.7) followed by Two Hoe weeding. The Cost Benefit Ratio (CBR) of Atrazine is (1:60) which proved more profitable and cost effective.

Table 2: Effect of variety and weed control methods of maize on plant height (cm) at 4 and 8 weeks after sowing in May, June and July at Igbariam in 2021 and 2022 cropping seasons.

	Plant Height at 4WAS						Plant Height at 8WAS					
	May		June		July		May		June		July	
Treatment	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Variety(Var.)												
V1	64.7	60.1	64.8	62.4	64.8	63.0	204	201	205	203	203	202
V2	59.5	57.0	63.2	64.6	63.4	65.3	189	190	195	201	192	200
V3	63.2	61.6	60.5	61.1	61.4	62.2	192	191	191	196	189	201
Mean	62.4	59.5	62.8	62.7	63.2	63.5	195	194	197	200	194	201
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
WCM												
W0	49.9	46.3	49.5	47.3	50.6	46.4	108	106	114	112	108	106
W1	58.3	55.6	58.2	54.4	58.2	52.3	210	208	210	209	211	208
W2	81.6	80.2	82.7	81.3	83.1	80.6	249	239	248	246	249	244
W3	60.3	58.0	60.5	59.2	60.8	58.6	214	213	215	213	216	214
Mean	62.5	60.1	62.7	60.5	63.1	59.2	195	191	196	195	196	193
$LSD_{0.05}$	7.5	7.8	6.9	7.2	8.8	8.9	20.9	19.8	20.1	19.7	21.1	19.6
Interaction												
Var. x WCM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

NS = Not significan**t, W0** = Weedy check, **W1** = Hoe weeding (weeded control), **W2** = Pre-emergence herbicide application, **W3** = Post-emergence herbicide, **V1**= Oka Abakiliki, **V**2= Oka Bende, **V3** = Oka Nsukka, WCM= Weed control methods.

Table 3: Effect of variety and weed control methods of maize on plant girth (cm) and leaf area (cm^2) at 8 weeks after sowing in May, June and July at Igbariam in 2021 and 2022 cropping season.

	Plant Girth at 8WAS						Leaf Area at 8WAS					
	May		June		July		May		June		July	
Treatment	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Variety(Var.)												
V1	8.5	8.1	8.6	8.4	8.4	8.3	627	618	626	619	603	613
V2	9.2	9.0	9.7	9.6	9.5	9.3	657	645	663	640	629	637
V3	9.0	8.6	9.2	9.1	9.3	9.0	662	653	656	648	617	643
Mean	8.9	8.5	9.1	9.0	9.0	8.8	649	638	648	636	616	631
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
WCM												
W0	7.2	6.3	7.0	6.3	7.0	6.2	574	563	577	561	541	540
W1	8.6	8.3	8.2	8.4	8.0	8.3	617	611	614	608	575	564
W2	11.6	9.7	10.8	9.8	10.7	9.6	777	735	779	739	743	717
W3	8.6	8.0	8.6	8.2	8.4	8.0	627	618	627	620	596	590
Mean	9.0	8.0	8.6	8.1	8.4	8.0	649	618	649	632	614	602
$LSD_{0.05}$	4.0	3.0	3.5	3.0	3.5	3.1	ns	ns	ns	ns	ns	ns
Interaction												
Var. x WCM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

NS = Not significan**t, W0** = Weedy check, **W1** = Hoe weeding (weeded control), **W2** = Pre-emergence herbicide application, **W3** = Post-emergence herbicide, **V1**= Oka Abakiliki, **V**2= Oka Bende, **V3** = Oka Nsukka, WCM= Weed control methods.

Discussion

Maintenance of weed population at minimal level in a cropping system may be the most cost effective and achievable approach to weed management as complete weed eradication can be difficult to attain. The influence of weed control and cultivar on plant height, stem girth and leaf area as presented in Table 3 showed that control of weed with herbicide (Atrazine) gave the tallest plants, stem girth and leaf area at 249.0 cm, 11.6 mm and 1038.0 cm^2 respectively than the other treatments. The pre-emergence herbicide was able to suppress the weeds early thereby preventing the weeds from interfering with the growth and development of the maize plants at the critical periods (Manisankar et al., 2022, Jeetendra et al., 2023). The efficiency of the weed control methods in this research was previously observed by Saberali (2007). The cost and benefit ratio of each weed control method indicated that the pre-emergence and hoe weeding gave the highest revenue (ROI).

Table 4: Cost and benefit of selected weed treatment of maize production, 2021cropping season in Igbariam

Treatment	Atrazine (₦/ha)	Time of Treatment Application (Man-hr/ha)	Cost of Treatment Application (₦/ha)	Total cost (₦/ha)	Grain yield (kg/ha)	Revenue (₦/ha)	Net Revenue (profit) (₦/ha)	Cost & Benefit Ratio (CBR)
No weed	0.00	0.00	0.00	-	700	102,865	0.00	-
Atrazine 3m/ai/ha	5,000	5	2,500	7,500	3,140.60	461,511.17	454,011.17	1:60
Two Hoe Weeding	0.00	220	44,000	44,000	2,720.40	399,762.78	355,542.78	1:8
Post-emergence herbicide (Nicosulphuron)	5000	5	3,000	8,000	2,150.11	315,958.66	307,958.66	1:38

Foot Note:
*1kg of Maize = 146.95 naira (international price of maize = US Dollars 348.17/ton; 1 US Dollar = ₦422.08),
*Cost of Atrazine = 1,000 naira
*Cost of Nicosulphuron = 1,000 naira
*Cost of Hoe weeding = 200 naira 1/hr; done between 7:00am – 1:00pm = 6hrs approx.
*Cost of Application of Atrazine = 500 naira /hr; done between 7:00am – 12:00pm = 5hrs approx.

Table 5: Cost and benefit of selected weed treatment of maize production, 2022 cropping season in Igbariam

Treatment	Atrazine (₦/ha)	Time of Treatment Application (Man-hr/ha)	Cost of Treatment Application (₦/ha)	Total cost (₦/ha)	Grain yield (kg/ha)	Revenue (₦/ha)	Net Revenue (profit) (₦/ha)	Cost & Benefit Ratio (CBR)
No weed	0.00	0.00	0.00	-	800	117,560	0.00	-
Atrazine 3m/ai/ha	5,000	6	3,000	8,000	3,150.60	462,980.7	454,980.7	1:56
Two Hoe Weeding	0.00	230	46,000	46,000	2,420.40	355,677.7	309,677.7	1:6
Post-emergence herbicide (Nicosulphuron)	5500	7	3,500	9,000	2,150.11	315,958.6	306,958.6	1:34

Foot Note:
*1kg of Maize = 146.95 naira (international price of maize = US Dollars 348.17/ton; 1 US Dollar = ₦422.08),
*Cost of Atrazine = 1,000 naira
*Cost of Nicosulphuron = 1,000 naira
*Cost of Hoe weeding = 200 naira/hr; done between 7:00am – 1:00pm = 6hrs approx.
*Cost of Application of Atrazine = 500 naira /hr; done between 7:00am – 12:00pm = 5hrs approx.

Conclusion

The maize varieties planted at different months in both years had no significant difference from each other in terms of germination and other growth parameters. Whereas, pre-emergence herbicide gave the best option for weed control in the present study, and were better than hoe weeding twice. This option may appeal to small holder farmers (hoe weeding), who may be ready to adopt it; since it does not involve much. However, it is more feasible at a commercial farm level where large hectares of land are involved.

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