INFLUENCE OF WEED CONTROL MEASURES ON THE GROWTH AND YIELD OF MAIZE (*Zea mays* L) IN AN ULTISOL SANDY LOAM

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ABSTRACT

In Nigeria, maize is one of the most important crops for human consumption. It is also an essential component for feed production. However, maize production is constrained by weed infestation. This experiment was carried out to study the effect of different weed control measures on the growth and yield of maize in Anyigba, Dekina Local Government area of Kogi State. Two herbicides (atrazine at the rate of 3 kg/ha and Nicosulfuron at the rate of 1 kg/ha) and hand hoeing were used solely or in combinations to obtain nine (9) treatments and replicated three times in a randomized complete block design. Results showed significant differences in growth characteristics such as plant height and sheath length at 8 weeks after sowing on plots that received atrazine 3 kg a.i/ha + hand hoeing once + Nicosulfuron 1 kg a.i/ha treatment. Yield components of maize such as ear length, number of kernels per row, number of kernels per ear, kernel weight per ear and hundred kernel weight showed highly significant differences at 0.01 level of probability. The major weeds observed during the study were elephant grass (Pennisetum purpureum) and Milkweed (Euphorbia heterophylla). In conclusion, plots that were treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha outperformed the other treated plots in terms of growth and yield of maize. The treatments tested for the control of Elephant grass and Milkweed showed similarity in performance but were different from the untreated plots except for Milkweed count at 77 days after sowing.

Keywords: ***atrazine; control; hoeing; maize; nicosulfuron; weeding***

INTRODUCTION

Maize (*Zea mays* L.) or corn, is an annual cereal crop grown in the world, along with rice (*Oryza sativa*) and wheat (*Triticum spp*.), with 2013 global commercial production of dried corn totalling 1,016.4 million metric tons, harvested from over 170 million hectares (FAOSTAT, 2013).

Maize grows well in various agroecologies and is unparalleled to any other crop due to its ability to adapt to diverse environments (Vigouroux *et al*., 2008). Furthermore, it has emerged as a crop of global importance owing to its multiple end uses as a human food and livestock feed and serve as a model organism for biological research worldwide. According to Shiferaw *et al.*, (2011) a major portion of maize produced worldwide is used for animal consumption as it serves as a vital source of protein and calories to billions of people in developing countries, particularly in Africa, Meso-America, and Asia. Also, it is a source of important vitamins and minerals for the human body. At present, the developed world uses more maize than the developing world, but forecasts indicate that by the year 2050, the demand for maize in developing countries will double owing to the rapid growth in the poultry industry, the biggest driver of growth in maize production (Rosegrant *et al.*, 2009; Prasanna, 2014).

Research by Sharma *et al*., (1998) and Zaciragic and Grabo, (2003) showed that

maize plants are very susceptible to weed competition and yield losses are estimated at 35 % to complete crop failure. Under the favourite circumstances, farmers may lose 10-25 % of crop yield due to the abundance of weeds, while this percentage of loss might reach 25-50 % if farmers do not give any attention to controlling weeds as pests. To control such menace, herbicide usage in maize production is on the increase and traditional weed management strategies for maize are no longer applied in many areas (Isaac *et al.*, 2013). Traditional methods are full of drudgery, time-consuming, labour-intensive, and expensive per hectare and offer little hope for expanding the present farm size (Waweru *et al*., 2017; Imoloame *et al*., 2013).

Chemical weed control is playing an increasing role in Nigerian agriculture due to the increasing cost and widespread unavailability of labour required to carry out traditional weed management. It is considered a practical and economic alternative to manual weeding; it is cheaper, faster, minimizes drudgery, gives better control of weeds, and increases the economic and biological yield of crops (Chikoye *et al*., 2004; Haider *et al*., 2019). Integrated Weed Management (IWM) is a more recent strategy that combines two or more methods of weed management to give results that are superior to those obtained when a single method is used (Das, 2012). Atrazine with a chemical formula, C8H14CIN5 is a systemic and selective herbicide used to control annual grasses and broad-leaf weeds. Likewise, nicosulforon with a chemical formula, C15H18N6 is a selective and systemic herbicide used in controlling annual weeds such as maize and sorghum (Sebiomo, and Banjo, 2021). Therefore, the objective of this study was to determine the response of maize to the application of two herbicides (Atrazine and Nicosulfuron) and hand hoeing solely and in combinations.

MATERIALS AND METHODS

The experiment was carried out at Student Research and Demonstration Farm, Prince Abubakar Audu University, Anyigba, Kogi State during the 2021 cropping season. Oba super-2 variety of maize seed with 80 days maturity was sourced from Agricultural Development Project, Anyigba branch Kogi State. Two herbicides (Atrazine and Nicosulfuron) were obtained fromAnyigba market.Nine treatment combinations include; Atrazine 3 kg a.i/ha and Nicosulfuron 1 kg a.i/ha, Atrazine 3 kg a.i/ha with hand hoeing once, Nicosulfuron 1 kg a.i/ha with hand hoeing once, Atrazine 3 kg a.i/ha with hand hoeing twice, Nicosulfuron 1 kg a.i/ha with hand hoeing twice, Atrazine 3 kg a.i/ha and Nicosulfuron 1 kg a.i/ha with hand hoeing once, Atrazine 3 kg a.i/ha and hand hoeing once with Nicosulfuron 1 kg a.i/ha, Hand hoeing twice and Untreated plot. The treatments were laid in a randomized complete block design (RCBD) in three replications. Five-row plots of 3 m each were used in the experiment with an intra and inter-row spacing of 0.3 and 0.75 m. Originally, three seeds were planted per hill but eventually thinned to a single plant per hill. 120 kg N of NPK 15:15:15 in split doses was applied at 2 weeks and 6 weeks after planting. Data were recorded on six sampled plants weekly for plant height, sheath length, sheath width, ear length, number of rows per ear, number of kernels per row, number of kernels per ear, kernel weight per ear, and 100-kernel weight. Plant height, sheath length, sheath width and ear length were measured using the meter rule graduated in centimetres. The number of rows per ear, the number of kernels per row, number of kernels per ear were counted. While kernel weight per ear, and 100-kernel weight were taken using weighing balance (ISC070501 Model) in

grams. Weed density was determined by counting the dominant weed species within each plot and the number recorded. Data collected were subjected to analysis of variance (ANOVA) and significant means were separated using Fisher's Least Significant Difference at a 5% level of probability using Statistical Tools for Agricultural Research (STAR).

RESULTS

Growth Components

Plant height

The height of maize in relation to different weed control measures applied varied throughout the period of the experiment (Table 1). A highly significant difference was recorded at 8 weeks after sowing. The treated plots outperformed the untreated plots throughout the duration of the experiment. Among the treated plots, the shortest plants with a mean of 52.27 cm were recorded at plots treated with Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha + Hand hoeing once while the tallest plants were recorded at the plots treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha with the mean value of 189.43 cm. In addition, the plots treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha gave the best performance in terms of maize height followed by Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha treated plots. This suggests that the application of pre-emergence herbicide at the early stage of maize growth will go a long way in the control of weeds throughout the growing period of the crop.

Sheath length

The mean performance of maize in terms of sheath length response to different weed control measures was observed in (Table 1). The treatments showed non-significance at 0.01 level of probability at 4 and 6 weeks after sowing. Sheath length was highly significant at 0.01 level of probability with a least significant difference of 12.19 cm at 8 weeks after sowing. The lowest means (51.00 cm) were observed at plots that received Nicosulfuron 1 kg a.i/ha + Hand hoeing once and Atrazine 3 kg a.i/ha + Hand hoeing once. However, plots treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha had the highest mean (94.00 cm) throughout the period of the experiment. Hence plots treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha is ahead in terms of length of sheath compared to the rest of the weed control treatments.

Sheath width

The sheath width of maize in response to different weed control measures was observed in (Table 1). The treatments were not significant at a 0.05 level of probability across all three stages of growth. The narrowest sheath (4.20 cm) was observed at plots treated with Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha + Hand hoeing once at 4 weeks after sowing. However, the broadest sheath (8.97 cm) and obviously the best treatment in terms of sheath width were recorded at plots that received Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha at 8 weeks after sowing.

In terms of the growth parameters studied, plots that received Atrazine 3 kg a.i/ha + Hand hoeing once +Nicosulfuron 1 kg a.i/ha ranked ahead in terms of height, sheath length and width. This is followed by the plots that received Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha. Compared to the untreated plots, plots where Nicosulfuron 1 kg a.i/ha + hand hoeing once was applied had the least maize growth.

Table 1: Effect of different weed control measures on growth components of maize in an ultisol sandy loam during the 2021 growing season.

	Plant height (cm)			Sheath length (cm)			Sheath width (cm)		
Treatment (s)	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
Untreated plot	55.30	69.23	135.20^{b}	52.53	81.20	82.97^{ab}	4.37	6.27	7.37
Hand hoeing twice	65.00	83.13	175.93^{ab}	54.00	83.47	89.67^{ab}	4.70	7.40	8.57
Atrazine 3 kg a.i/ha + hand hoeing once	54.57	70.97	155.37^{ab}	51.00	83.23	85.30^{ab}	4.30	7.13	8.23
Atrazine 3 kg a.i/ha + hand hoeing twice	57.17	76.67	157.43^{ab}	54.60	82.23	86.33^{ab}	5.00	7.63	8.93
Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha	66.00	87.23	182.77^{a}	58.40	89.33	92.73^{ab}	5.00	7.87	9.20
Nicosulfuron 1 kg a.i/ha + hand hoeing once	49.40	69.47	154.43^{ab}	51.00	75.07	80.97^{b}	4.27	6.97	8.30
Nicosulfuron 1 kg a.i/ha + hand hoeing twice	65.50	81.17	158.27^{ab}	55.03	83.43	86.97^{ab}	4.53	6.93	8.27
Atrazine 3 kg a.i/ha + Nicosulfulron kg a.i/ha + Hand hoeing once	52.27	69.97	149.13^{ab}	50.13	79.07	87.60^{ab}	4.20	6.43	8.43
Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha	67.10	87.00	189.43^{ab}	60.57	89.57	94.00^{a}	5.00	7.97	8.97
LOS	NS	NS	**	NS	NS	**	NS	NS	NS
LSD	-	-	47.01	-	-	12.19	-	-	-

**= 0.01 level of probability, NS =Non-significant, LSD = Least significant difference, LOS = Level of significance, WAS = Weeks after sowing

Yield Components of Maize

The effect of different weed control methods on the yield components of maize is shown in Table 2. Varying weed control measures showed highly significant differences for the components studied at 0.01 level of probability except for the number of rows per ear. The longest ear of 15.25 cm was observed in a plot where Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha was applied, followed by Nicosulfuron 1 kg a.i/ha + Hand hoeing twice (14.93 cm) and Altrazine 3 kg a.i/ha + Hand hoeing once (14.59 cm) while the shortest ear of 9.76 cm was observed in the control plots. Furthermore, yield components such as number of rows per ear, number of kernels per row, number of kernels per ear and kernel weight per ear have the highest mean performance of 14.00, 33.93, 470.53 and 469.57 g at plots treated with Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha and the lowest means of 13.87, 20.40, 282.67

and 180.37 g at the control plots. The heaviest kernel of 20.70g in a hundred counts was recorded at plots treated with Nicosulfuron 1 kg a.i/ha + Hand hoeing twice which was very close to Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha (20.67g) plots, while the lightest kernel of 13. 40g in hundred counts was recorded at the control plots.

Table 2: Effect of different weed control measures on yield components of maize in an ultisol sandy loam during the 2021 growing season.

Treatment (s)	Ear length (cm)	Number of rows per ear	Number of kernels per row	Number of kernels per ear	Kernel weight per ear (g)	Hundred kernel weight (g)
Untreated plot	9.76^{b}	13.87	20.40^{b}	282.67^{c}	180.37^{c}	13.40^{b}
Hand hoeing twice	14.09^{a}	13.87	30.20^{a}	416.27^{ab}	401.50^{ab}	19.87^{a}
Atrazine 3 kg a.i/ha + Hand hoeing once	14.59^{a}	12.93	30.13^{a}	391.47^{b}	357.67^{ab}	18.03^{a}
Atrazine 3 kg a.i/ha + Hand hoeing twice	13.65^{a}	13.07	28.33^{a}	368.13^{b}	331.20^{b}	17.67^{a}
Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha	14.36^{a}	13.73	29.07^{a}	395.07^{b}	357.07^{ab}	18.13^{a}
Nicosulfuron 1 kg a.i/ha + Hand hoeing once	13.76^{a}	13.07	28.80a	376.00^{b}	388.23^{ab}	20.70^{a}
Nicosulfuron 1 kg a.i/ha + Hand hoeing twice	14.93^{a}	13.60	29.60^{a}	410.67^{ab}	372.07^{ab}	18.33^{a}
Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha + Hand hoeing once	14.17^{a}	13.60	30.27^{a}	413.20^{ab}	341.40^{b}	16.97^{a}
Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfuron 1 kg a.i/ha	15.25^{a}	14.00	33.93^{a}	470.53^{a}	469.57^{a}	20.67^{a}
LOS	**	**NS**	**	**	**	**
LSD	**3.67**	**-**	**6.35**	**63.35**	**120.32**	**4.00**

**= 0.01 level of probability, NS =Non-significant, LSD = Least significant difference, LOS = Level of significance.

Weed Density

The major weeds observed on the maize plot are shown in Table 3. Elephant grass (*Pennisetum purpureum*) and Milkweed (*Euphorbia heterophylla*) were the predominant weeds observed on the plots. The highest counts of weeds were recorded on the untreated plot throughout the study. There were no significant differences between the treatments tested for the management of Elephant grass except with the untreated plot at 44 and 77 days after sowing. Similarly, there were no significant differences between treatment means for the control of Milkweed at 44 days after sowing except with the untreated plot. However, differences were observed among treatments tested for the control of Milkweed at 77 days after sowing. Nevertheless, *Euphorbia heterophylla* was more prevalent compared to *Pennisetum purpureum*.

DISCUSSION

Maize is very susceptible to competition from weeds. Such competition results in severe yield losses. To control such menace, herbicides used in maize production are on a dramatically increasing trend, and traditional weed management strategies for maize are no longer applied in some areas (Isaac *et al.*, 2013). Kolo *et al.*, (2012) detected that weed control practices significantly affect maize grain yield and 100 seed weight. Grain yield declined with a delay in the planting date. Also, the lowest weed density was found in plots sprayed with atrazine while the highest weed density was found in control plots.

Table 3: Effect of different weed control measures on the population of elephant grass and milkweed in an ultisol sandy loam during the 2021 growing season.

Treatment(s)	Elephant grass (*Pennisetum purpureum*)		Milkweed (*Euphorbia heterophylla*)	
	Forty-four days	Seventy-seven days	Forty-four days	Seventy-seven days
Untreated plot	9.33[a]	7.33[a]	15.67[a]	15.00[a]
Hand hoeing twice	0.00[b]	1.33[b]	0.00[b]	5.67[ab]
Atrazine 3 kg a.i/ha + Hand hoeing once	1.67[b]	3.33[b]	1.67[b]	3.33[b]
Atrazine 3 kg a.i/ha + Hand hoeing twice	0.00[b]	0.00[b]	0.67[b]	1.33[b]
Atrazine 3 kg a.i/ha + Nicosulfuronkga.i/ha	1.33[b]	2.67[b]	0.00[b]	0.67[b]
Nicosulfuron 1 kg a.i/ha + Hand hoeing once	2.33[b]	2.00[b]	0.67[b]	1.67[b]
Nicosulfulron kg a.i/ha + Hand hoeing twice	0.00[b]	1.33[b]	0.00[b]	5.33[b]
Atrazine 3 kg a.i/ha + Nicosulfuron 1 kg a.i/ha + Hand hoeing once	2.67[b]	2.67[b]	0.00[b]	0.00[b]
Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfulron 1 kg a.i/ha	1.33[b]	0.33[b]	0.33[b]	1.00[b]
LOS	**	**	**	**
LSD	**4.52**	**10.32**	**4.00**	**9.48**

**=0.01 level of probability, LSD = Least significant difference, LOS = Level of significance.

The significant increases in maize plant height at 8 weeks after sowing obtained in all treatments other than the control reflect the reduced effects of weed competition as affected by the various treatments in the experimental plots. Higher weed density competes with maize for nutrients, soil, moisture, light and carbon dioxide and considerably reduces plant growth including plant height (Hassan, 2005). The variation in plant height of maize in all weed control treatments could be attributed to varying effects of weed competition for available resources offered by different weed densities in different weed control practices.

The increases in maize sheath length as observed in treated plots against control plots was mainly due to improved growth as a consequence of effective control of weeds and reduction in crop weed competition which might have enabled the maize crop to take up more nutrients Takim *et al*., (2012).

The better performance of maize in terms of plant height and sheath length in treated plots might be associated with the ability of Atrazine and Nicosulfuron to prevent weed seeds from germinating thereby favouring maize growth. The healthy growth of maize impacted effective pollination and yield production. This was consistent with the findings of Yeganehpoor *et al*. (2013) who showed that treated plots in maize achieved the highest mean value of ear length, number of grain rows per ear, dry ear weight, weight of 100 grains, and biological yield compared to other treatments.

Yield components such as ear length, number of rows per ear, number of kernels per row, number of kernels per ear, kernel weight per ear, and hundred kernel weight, have been used to measure the performance of maize after harvest. Furthermore, plots treated with atrazine with hand hoeing once and nicosulfuron as post-emergence

herbicide had the highest mean performance for all the yield components while the untreated plot had the lowest mean value for all the yield components except the number of rows per ear. These results were similar, more or less, to the findings of Mekky *et al*. (2002), Hassan *et al*. (2005), Ali *et al*. (2011), Takim *et al*. (2012), and Yeganehpoor *et al*. (2013), Muhammed *et al*. (2017).

Kolo *et al.*, (2012) detected that weed control practices have a significant effect on maize grain yield and 100 seed weight. Grain yield declined with a delay in the planting date. Also, the lowest weed density and the lowest dry weed biomass were found in plots that were sprayed with atrazine while the highest weed density and the highest dry weed biomass were found in control plots.

The prevalence of *Euphorbia heterophylla* over *Pennisetum purpureum* suggests that the former grows at a faster rate than the latter and would compete more with maize for space, sunlight, CO_2 and water. It is also worth mentioning that, the lowest count for both weed species at 44 days after sowing was achieved at plots treated with Nicosulfuron + Hand hoeing once and Hand hoeing twice. This indicates the effectiveness of Nicosulfuron in the control of both weed species at an early stage of maize growth.

CONCLUSIONS AND RECOMMENDATIONS

In the response of maize to Altrazine, Nicosulfuron and hand hoeing solely, twice and in combinations revealed that Atrazine 3 kg a.i/ha + Hand hoeing once + Nicosulfulron 1 kg a.i/ha outperformed the untreated plots and the rest of the treatments tested for growth parameters such as plant height, sheath length and sheath width. The same treatment excelled for yield components such as ear length, number of rows per ear, number of kernels per ear, number of kernels per row, kernel weight per plant and hundred kernel weight. However, the same was not observed for weed density. The treatments tested for the management of Elephant grass and Milkweed showed similarity in performance but were different from the untreated plots except for Milkweed count at 77 days after sowing. Further research should be conducted to ascertain the validity of this experiment.

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