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Evaluation of Herbicide Spray Programmes and Hoeing for Weed Control in Maize (*Zea mays* L.) In a South Western Nigerian Location

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Abstract: Field studies were conducted in 2003 and 2004 at the experimental site of the Department of plant Science, University of Ado-Ekiti (7°40'N, 5°14'E) to evaluate the effects of herbicide spray programmes and hand hoeing on weed control in maize. Pre-plant glyphosate (360 g aqueous solution) application to weed regrowth after land preparation followed by early post emergence application of atrazine (480 F) to maize gave the best weed density and biomass reduction and the highest maize yield. The density of grass weeds was lowest in the glyphosate applied plots while the lowest broadleaved weed density was recorded in atrazine sprayed plots. Glyphosate application supplemented with hoe weeding gave comparable weed reduction and good maize yield with the combination of glyphosate and atrazine. It is concluded that effective weed control in grass land maize production could be achieved by a pre-plant glyphosate application followed by post emergence atrazine application to improve maize yield.

Key words: Zea mays, grassweeds, glyphosate, atrazine, grain yield

INTRODUCTION

Maize (*Zea mays* L.) is most sensitive to weed competition during the early phase of its growth as it grows slowly during the first 3 to 4 weeks (Sandhu *et al*., 1986). Yield reduction in maize results from high competition between the crop and weed for water, light and nutrients (Tollenaar *et al*., 1997) especially when the competing weeds are of the same family with maize. It has been observed that if weeds are not controlled, there is a critical crop-weed competition period with grain losses reaching between 35 and 70% (Ford and Pleasant, 1994). Eighteen plant species have been considered to be most important weed species on adaptability and plasticity (Holm *et al*., 1977). Of these were 10 grasses and 2 sedges.

Among the various factors influencing the response of maize to weed control are the species present and their density (Bendixen, 1998; Young *et al*., 1984) and the type of control employed (Jat, 1998; Saikia and Pandey, 1999). Maize and other, grass weeds belong to the same family Poaceae and the efforts geared towards protecting maize against weed infestation may also be protecting some of these grass weeds. This is because of the identical biochemical properties shared by maize and these grass weeds (Aladesanwa and Ademiluyi, 1996).

The present study was conducted to assess the effect of weed control methods on maize grown on plots of land predominantly occupied by grass weeds.

MATERIALS AND METHODS

Field trials were conducted during the cropping seasons of 2003 and 2004 at the experimental site of the Department of Plant Science, Faculty of Science, University of Ado-Ekiti, Nigeria (8°45'N, 5°15'E). The location of the experiment is 430 m above sea level and enjoys the same atmospheric conditions with Ado-Ekiti and its environs. The field had been under *Panicum maximum* Jack. and a few *Chromolaena odorata* (L.) R.M. King and Robinson, fallow for about 3 years.

The experimental design was a randomized complete block with four replicates per treatment. There were eight weed control methods used. These were: Weedy check; Glyphosate at 2.4 kg a.i.ha^{-1}, applied 2 Weeks Before Planting (WBP); Glyphosate at 2 WBP + Atrazine at 2 Weeks after Planting (WAP); Glyphosate at 2WBP + hoeing at 3 WAP; Glyphosate at 2 WBP + hoeing at 5 WAP; Glyphosate at 2 WBP + hoeing at 3 and 7 WAP; Hoeing at 3 and 7 WAP and Atrazine at 2 WAP.

The experimental field was manually cleared and ridged. The ridges were left for 4 weeks to allow weed regrowth. Plots receiving glyphosate application were then sprayed 2 WBP at 2.4 kg a.i.ha^{-1} while those that received atrazine were applied 2 WAP at 3.0 kg a.i.ha^{-1}. Hoeing was carried out either at 3, 5 or 3 and 7 WAP using Nigerian hoe. Two seeds of maize (variety-Downy mildew swamp) were planted and later thinned to one per stand two weeks after emergence.

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Plant height was determined at 4 WAP using a metre rule. Weeds were sampled twice at 4 and 8 WAP by using a 1.0 m^2 quadrat placed at two sites randomly per plot. Collected weed species were separated by species counted, oven dried at 40°C for 48 h and then weighed. Composition of weed flora (%) was determined. Days to 50% tarselling was determined by observing the number of days after planting that takes 50% of plants per plot to tassel.

Yield was assessed from 10 plants randomly selected per plot. The harvested cobs were dried to constant weights, weighed, shelled and grain weight determined. All data were statistically analysed using analysis of variance and means compared according to the Duncan's Multiple Range Test (Little and Hills, 1978).

RESULTS

The predominant grass weeds were *Panicum maximum*, (Jacq), *Cynodon dactylon* L and *Imperata cylindrica* Jacq in both seasons. The broad-leaved weeds were *Amaranthus spinosus* (Linn), *Tridax procumbens* (Linn) and *Tithornia diversifolia* (Helm), A. Gray. *Cynodon dactylon* (L) and *Mariscus alternifolius* Vahl was the only sedge observed.

The effects of weed control on weed density at 4 and 8 WAP are presented in Table 1. The highest weed density was recorded in the weedy check plots in both seasons at 4 and 8 WAP while the lowest weed density was recorded in the plots receiving the combination of glyphosate and atrazine both at 4 and 8 WAP in year 2004. Glyphosate at 2 WBP was not significantly different from atrazine at 2 WAP in terms of weed density. The least weed biomass was recorded in the plots receiving the combination of glyphosate and atrazine plots while the highest was recorded in the weedy check control plots both at 4 and 8 WAP in both seasons. Glyphosate application followed by hoe weeding either at 3 WAP, 5 WAP or 3 and 7 WAP were not significantly different but significantly lower than hoe weeding at 3 and 7 WAP only (Table 2).

Table 1: Effects of weed control methods on weed density (Nom^{-2}) at 4 and 8 WAP

	Weed density at 4 WAP		Weed density at 8 WAP	
Treatments	2003	2004	2003	2004
Glyphosate at 2 WBP	22.0b	20.0c	25.0b	23.0b
G + At	5.6c	2.0e	7.0d	6.7e
G + H at 3 WAP	7.5c	2.0e	8.4d	12.7d
G + H at 5 WAP	6.6c	7.3d	6.6d	16.7c
G + H at 3 and 7WAP	5.1c	8.0d	9.1cd	12.7d
H at 3 and 7 WAP	10.2c	11.3d	18.1bc	12.7d
At at 2 WAP	20b	25.0b	22.5b	20.0b
Weedy check	46.0a	35.0a	61.6a	33.0a

Means with the same letter(s) within column are not significantly different ($p<0.05$) according to DMRT, N.B: G = Glyphosate; At = Atrazine; H = Hoeing, WBP = Weeks Before Planting WAP = Weeks After Planting

The effects of weed control on the composition of weed flora (%) are presented in Fig. 1. The highest grass weed frequency of 90% was recorded in the weedy check plots while only 5% each of broadleaved and sedges were recorded in 2003. In the glyphosate applied plots, only

Table 2: Effects of weed control methods on on days to 50% tasselling

	Weed biomass (4 WAP)		Weed biomass (8 WAP)	
Treatments	2003	2004	2003	2004
Glyphosate at 2 WBP	79.6b	28.0b	121.7b	86.2c
G + At	7.8e	1.3e	10.5d	3.4e
G + H at 3 WAP	18.5d	2.1e	18.7d	8.7e
G + H at 5 WAP	22.4d	5.4d	17.5d	7.1e
G + H at 3 and 7WAP	10.5ed	2.5e	19.1d	5.7e
H at 3 and 7 WAP	56.4c	14.5c	58.7c	37.2d
At at 2 WAP	49.5c	31.8b	152.9b	141.9b
Weedy check	230.1a	20.8.0a	418.2a	366.5a

Means with the same letter(s) within column are not significantly different ($p<0.05$) according to DMRT. N.B: G = Glyphosate; At = Atrazine; H = Hoeing, WBP = Weeks Before Planting WAP = Weeks After Planting

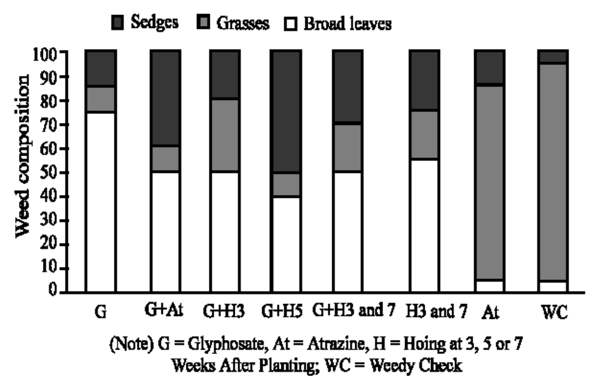

Fig. 1a: Treatment effects on weed flora composition (%) in 2003

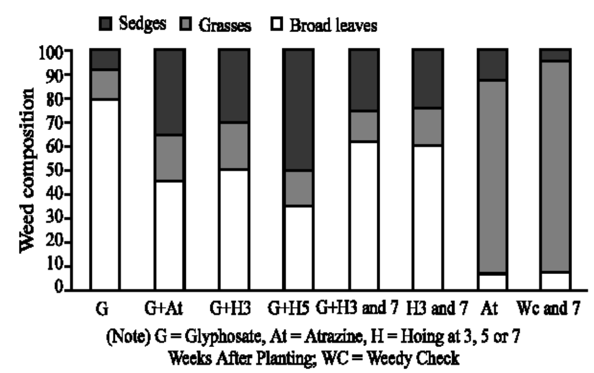

Fig. 1b: Treatment effect on weed flora composition (%) in 2004

12 and 10% and 18 and 15% of grass weeds and sedges were recorded in 2003 and 2004, respectively. Atrazine application reduced the frequency of broadleaved weeds in the glyphosate sprayed plots. Eighty two and 80% grass weed frequency were recorded in the plots sprayed with atrazine alone.

Days to 50% tasselling of maize was affected by the the weed control methods. The earliest day to tasselling was recorded in the plots receiving the combination of glyphosate and atrazine, while the least was recorded in the weedy check plots. No significant difference in days to 50% tasselling was indicated between glyphosate and atrazine sprayed plots (Table 3).

Yield assessment showed that plant height at 4 WAP, cob and grain yield were consistently highest in the glyphosate + atrazine treated plots but were not significantly different from those of glyphosate + hoeing at 3 WAP. Yields obtained from atrazine sprayed plots were significantly lower than those from glyphosate treated plots. The grain yields of 6.4 and 5.9 tha^{-1} were obtained in the glyphosate + atrazine treated plots as against 4.5 and 4.9 tha^{-1} in the hoe weeded plots at 3 and 7 WAP in 2003 and 2004 seasons, respectively. The lowest yields were obtained from the weedy check plots (Table 4).

Table 3: Effects of weed control methods on days to 50% tasselling

Treatments	Days to 50% tasselling 2003	2004
Glyphosate at 2 WBP	55.5bc	58.7bc
G + At	51.2e	55.3d
G + H at 3 WAP	53.0d	57.3c
G + H at 5 WAP	54.5c	58.7bc
G + H at 3 and 7WAP	53.5d	57.3c
H at 3 and 7 WAP	53.7d	56.8cd
At at 2 WAP	56.1b	59.3b
Weedy check	58.5a	61.7a

Means with the same letter(s) within column are not significantly different ($p<0.05$) according to DMRT. N.B: G = Glyphosate; At = Atrazine; H = Hoeing, WBP = Weeks Before Planting WAP = Weeks After Planting

Table 4: Effects of weed control methods on maize yield components

Treatments	Plant height (cm)		Cob yield tha^{-1}		Grain yield tha^{-1}	
Glyphosate at 2 WBP	2003	2004	2003	2004	2003	2004
Glyphosate at 2 WBP	35.6b	35.1b	3.8e	3.2c	1.6c	2.7c
G + At	40.5a	39.5a	10.4a	9.8a	6.4a	5.9a
G + H at 3 WAP	39.1a	37.0a	9.2a	9.3a	6.0a	6.1a
G + H at 5 WAP	36.4b	34.4b	7.9bc	8.7a	4.5b	5.5a
G + H at 3 and 7 WAP	37.5ab	37.0a	6.5cd	6.2b	4.3b	5.1ab
H at 3 and 7 WAP	36.1b	39.0a	5.4d	5.8b	4.5b	4.9b
At at 2 WAP	35.4b	35.0b	2.9f	1.5d	0.9d	1.2d
Weedy check	30.5c	26.5c	0.5g	0.0e	0.1e	0.0e

Means with the same letter (s) within column are not significantly different ($p<0.05$) according to DMRT. N.B: G = Glyphosate; At = Atrazine; H = Hoeing, WBP = Weeks Before Planting WAP = Weeks After Planting

DISCUSSION

The result of this research clearly show that pre-plant glyphosate application to control weed re-growth after land preparation, followed by post emergence atrazine application to control the resurgence of broadleaved weed species will be beneficial in reducing weed infestation and improve maize yield in the study area.

Glyphosate applied pre-plant to weed re-growth without the addition of any other weed control treatment had little effect in reducing weed density and biomass probably because of the resurgence of broad-leaved weeds. Glyphosate is a nonselective broad spectrum herbicide that controls all weed species both annual and perennial (Cessna *et al*., 2002). It is readily absorbed by living foliage and translocated with assimilates to areas of high metabolic activities. It is not a soil acting herbicide. Also, Atrazine applied post emergence was unable to give satisfactory weed control presumably because of its inability to control these grass weeds that predominate in the experimental plots. Similar poor grass weed control in maize production had been reported by Sandhu *et al*. (1986).

The satisfactory weed control and higher yield achieved by preplant glyphosate application followed by post emergence application of atrazine presumably resulted from the effective grass weed control by glyphosate and satisfactory control of broadleaved weed resurgence by atrazine. Chirita (1987) had reported similar findings when post emergence application of 2, 4-D and dicamba following pre-emergence application of EPTC gave the best weed control and highest maize yield compared with other pre or post-emergence herbicides applied alone. Glyphosate applied alone showed higher yield than atrazine applied alone. This probably reflects the high competition between maize and grass weeds that were not controlled by atrazine due to their similarities.

Also glyphosate with supplementary hoe weeding gave similar advantage with glyphosate + atrazine in both weed control and maize performance. It is also clear from this study that glyphosate improved the efficacy of hoe weeding (at 3 and 7 WAP) and may reduce hoe weeding regime from twice to once.

The presence of weeds in this study delayed tasselling apart from yield reduction. While the speed of tasselling was increased in the glyphosate + atrazine sprayed plots. The reduction in yield and delay in tasselling in the weedy check plots might have resulted from the highest grass weed composition in such plots.

It is clear from this study that the use of glyphosate pre-plant followed by post-emergence atrazine application will prove beneficial in reducing grass and broad leaved weed infestation in maize, give faster growth rate by increasing the speed of days to 50% tasselling and increase maize yield.

CONCLUSION

It is concluded that the efficacy of atrazine which is a selective herbicide for maize could be increased by a pre-plant glyphosate application while weeding regimes by farmers could be reduced by pre-plant application of glyphosate in such a grass land maize production. The implication of these findings is that weed species composition in a farmland should be assessed before recommending an appropriate weed control method in maize production.

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