

Stage of shoot regrowth of speargrass *Imperata cylindrica* L on control with glyphosate.

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Abstract

Field studies were conducted at Ilorin and Mokwa, in the southern Guinea savanna of Nigeria, in 2008, 2010 and 2009, respectively to determine the effect of age of leaf re-growth of speargrass (*Imperata cylindrica*) and dose of Glyphosate [N-(phosphonomethyl) glycine] application on the control of the weed. In both locations, density of speargrass shoots decreased with an increase in the rate of Glyphosate application from 0.94 to 3.76 kg ae/ha; while lower shoots and rhizomes fresh weight were obtained when Glyphosate was applied at 1.88 – 3.76 kg ae/ha to spear grass foliage at 3 – 4 weeks re growth stage after slashing. Results of this study show that for optimal control of speargrass, the re-growth should be about 3 – 4 weeks from slashing while between 1.88 – 2.82 kg ae/ha of Glyphosate can achieve control at this stage of re-growth. This study established that age of re-growth of speargrass from slashing influences the efficacy of Glyphosate irrespective of the dose on its control.

Key words: *Imperata cylindrica*, Glyphosate, slashing regime, application rate

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Introduction

Speargrass [*Imperata cylindrica* (L.) Raeschel] is ranked as the 10th most important weed in the world and considered to be the worst rhizomatous perennial grass

weed (Holm *et al.* 1977). It is a widespread, and problematic weed in the lowland moist savannas of West and Central Africa and forest fringes where human population pressure on land has prevented the re-

establishment of forest vegetation (Udensi *et al.* 1999). It is thus a problematic weed in most farmlands in Nigeria (Avav, 2002).

Chikoye *et al.* (1999) reported that speargrass is widespread where recurrent fires, tillage, weeding and other farm activities continuously disturb land. The annual hoe-weeding and conventional tillage practices increase and aid in redistributing the vegetative rhizome propagative structure (Akobundu and Ekeleme, 2000).

Competition from speargrass can cause crop yield losses of over 50 % in maize and soybean (Chikoye *et al.* 2000) and over 90 % in cassava (Udensi *et al.* 1999). The losses caused by speargrass are greater on roots and tuber crops (Chikoye *et al.* 2001) due to its rhizome. Apart from the direct competition for organic resources, the rhizomes of the weed pierce roots and tubers thereby creating avenues for secondary infestation by insect pests and disease pathogens (Terry *et al.* 1997). Managing perennial weeds, especially speargrass, is generally more difficult because of their multiple reproductive systems (Byrd and Bryson, 1999). Smallholder farmers are unable to adequately control the weed resulting sometimes in abandonment of infested fields owing to poor crop yield, low cash returns from physically damaged produce (particularly in root and tuber crops), and the high cost of labour needed to cultivate infested fields (Akobundu and Ekeleme, 2000). Hand weeding, deep tillage, slashing, burning, use of cover crops and herbicides are some of the methods that have been used with varying degrees of success for its control. However, the use of herbicides has been reported to be the most appropriate option method for the control of the weed, with Glyphosate being the most promising

herbicide for control of the weed, in sub-humid tropics of West Africa (Udensi *et al.* 1999; Lum *et al.* 2005).

Glyphosate [N-(phosphonomethy 1) glycine], a broad spectrum systemic herbicide, has been the most widely used herbicide for speargrass control in Nigeria (Avav, 2000; Lum and Chikoye, 2005). Monsanto Company (1988) has recommended the use of 2.88-3.60 kg a.e./ha of glyphosate for effective control of the full grown weeds, with foliage height of 100 cm – 120 cm. However, less than 3 % of farmers use herbicides in West Africa to control speargrass (Chikoye *et al.* 2000). This could be due to the financial constraint or insufficient resources to purchase input to control the weed (Taiwo and Ekeleme, 2008).

In order to minimize the menace of speargrass on smallholder farms in West Africa, where capital and labour are among the major constraints, there is need to develop a sustainable weed management technique that is affordable and yet effective in controlling the weed. This could be achieved with low rates of appropriate herbicides in combination with non-chemical control methods. This study was designed to determine the combination of age of speargrass shoot re growth after slashing and the rate of Glyphosate that could be used to achieve a satisfactory level of control of the weed.

Materials and Methods

The experiment was conducted at different sites at the University of Ilorin Teaching and Research Farm (9° 29' N, 4° 35' E) between August, 2008 and January, 2011 and at The Niger State College of Agriculture Research Farm, Mokwa (9° 16'

N, 5° 04' E) between July and October, 2009. Both locations are in the southern Guinea savanna zone of Nigeria. The experimental fields were dominated by speargrass.

Three trials were conducted between 2008 and 2011. Two of the trials (Trial I and Trial II) were in 2008 and 2009 and the third trial (Trial III between 2010 and 2011. In 2008 and 2009 were laid out as randomized complete blocks with a 2 x 5 factorial arrangement and replicated three times.

In August 2008, Trial I and Trial II were established in adjacent plots in Ilorin. In Trial I, two stages of speargrass shoot growth, "slashed" (slashing of an existing stand of speargrass and allowing the slashed shoots to re-grow for two weeks before applying Glyphosate), and "Not Slashed" (applying glyphosate to the existing stand of speargrass without slashing), in factorial combination with glyphosate applied at five rates (0, 0.94, 1.88, 2.82, and 3.76 kg ae./ha) and replicated three times.

In Trial II, glyphosate applied at two rates (0.94 and 1.88 kg ae./ha) were applied in factorial arrangement to five stages of speargrass shoot re-growth ("slashed" with zero, 2, 3 or 4 weeks of shoot re growth; and "not slashing") in three replicates. Trial I and II were repeated in Mokwa in 2009.

Trial III was conducted in Ilorin between September 2010 and January, 2011. The trial was designed as 5 x 5 factorial with a split-plot arrangement replicated three times. The main plot consisted of five slashing regimes as in Trial II while the sub-plot was made up of five rates of application of glyphosate as in Trial I. For all the trials, existing vegetation (including *Imperata cylindrica*) was manually slashed to ground level and the slashed vegetation was removed from the plot. Thereafter, shoot re growth from the slashed areas were allowed to develop for varying durations, depending on the

specific treatment, before application of the herbicide. Glyphosate was applied as Roundup (360 kg ae/ha) using a knapsack sprayer with a deflector-type nozzle in a spray volume of 200 L/ha. Each subplot was 12 m² in size.

Data were collected on speargrass shoot density at 3, 6, 8, 10, and 12 weeks after herbicide application (WAA). Speargrass shoot density were determined by enumerating the number of shoots from two 0.5 m² fixed quadrates on each of the sampling dates. In addition, the fresh weight of shoots and rhizomes of speargrass were determined at 12 WAA. The shoot fresh weight was determined by cutting the shoot within the quadrates at ground level. The rhizome fresh weight was assessed by excavating rhizomes within the same quadrate. Soil was washed off the rhizomes before fresh weight determination.

At Ilorin the experimental site was in 2010 was accidentally burned at 8 weeks after establishment. As such shoot density between 8 to 12 WAA could not be collected. However, rhizome biomass at 12 WAA and shoot emergence of speargrass after burning at 15 and 18 WAA were determined.

Data for each trial were subjected to analysis of variance (ANOVA) individually, using the GENSTAT (Gen Stat, 2003) procedures. Weed density data were square root transformed to normalize variance before ANOVA. Means were compared using the least significant difference (LSD) test.

Results

Trial I

Speargrass shoot density (3 and 6 WAA at Ilorin; 3, 6 and 9 WAA at Mokwa)

and rhizome fresh weight differed significantly with stage of shoot growth at both locations (Tables 1 and 2). Although not significant, speargrass shoot density in Ilorin at 9 and 12 WAA and in Mokwa at 12 WAA and shoot fresh weight in both locations at 12 WAA were generally lower

in slashed than un-slashed plots. Speargrass density was highest in the sprayed plots and decreased linearly as the dose of Glyphosate was increased in both locations except at 9 WAS at Ilorin and at 3 WAS at Mokwa (Table 1).

Table 1: Effect of Slashing Regime and Rate of Gyphosate Application on Density ($n0/m^2$) of *Imperata Cylindrica* Shoots at Ilorin and Mokwa (Trial 1)

Shoot Re- growth Stage (s)	Ilorin				Mokwa			
	Weeks After Application				Weeks After Application			
	3	6	9	12	3	6	9	12
2 Weeks	3.22	3.99	3.36	3.44	3.63	2.33	1.96	1.52
Mature Stand	6.19	4.34	3.76	3.87	8.85	5.88	4.29	2.05
LSD	2.12	0.44	NS	NS	4.21	NS	2.78	NS
Gyphosate Rate (Kg ae/ha) (G)								
0	25.94	24.44	23.94	19.92	70.70	65.50	43.22	42.71
0.94	15.72	15.94	14.53	14.72	21.80	19.21	16.82	11.70
1.88	4.56	3.94	3.61	2.47	8.68	8.81	6.01	11.31
3.76	2.92	2.89	3.06	2.86	9.51	5.15	4.51	1.17
LSD	2.35	2.09	NS	1.79	13.60	14.68	17.31	14.65
Interaction	NS	NS	NS	NS				

In both locations, 3.76 kg ae/ha gave the best control of the weed while 0.94 kg ae/ha had the least effect on speargrass shoot density. Speargrass shoot and rhizome fresh weight were significantly affected by dose

of Glyphosate (Table 2) at both locations. In both locations, fresh shoot and rhizome weight were significantly lower in the Glyphosate treated plots than in the untreated plots.

Table 2: Effects of Slashing Regime and Rate of Glyphosate Application on fresh weight (g/m²) of *Imperata Cylindrica* shoots and Rhizome at Ilorin and Mokwa (Trial 1)

	Ilorin	Mokwa	Ilorin	Mokwa
Shoot Re growth				
Stage (s)				
2 weeks	2.71	8.03	15.61	7.47
Mature Stand	4.75	11.82	29.23	18.93
LSD	NS	NS	4.43	5.73
Glyphosate Rate (Kg ae/ha) (G)				
0	17.04	16.68	44.60	12.27
0.94	7.60	9.83	35.22	8.07
1.88	4.15	9.77	18.21	6.90
2.82	3.51	9.32	13.51	7.18
3.76	2.30	9.03	10.45	6.58
LSD	2.80	4.47	5.41	3.87
Interaction				

Trial 2

The density of speargrass in the herbicide treated plots differed irrespective of stage of re growth of shoot at 3 and 6 WAS in Ilorin and at all sampling periods

except 9 WAS in Mokwa (Table 3). At Ilorin, shoot density was similar in plots treated after 2, 3 and 4 weeks after slashing.

Table 3: Effect of Rate of Glyphosate Application and Shoot Re growth on Density (no/m²) of *Imperata Cylindrica* Shoots at Ilorin and Mokwa (Trial 11)

Glyphosate Rate (kg ae/ha) (G)	Ilorin				Mokwa			
	Weeks After Application				Weeks After Application			
	3	6	9	12	3	6	9	12
0.94	40.31	32.11	32.01					
1.88	31.92	27.52	26.50	28.52	20.32	20.33	22.91	11.03
LSD	NS	NS	NS	15.72	14.52	16.92	16.11	9.70
Stage of growth of spear grass before herbicide application (S)				NS	NS	NS	5.94	NS
No growth	49.01	45.55	40.53	38.50	32.86	27.82	20.22	19.82
2 weeks re growth	21.32	20.01	16.32	13.67	18.33	16.32	12.78	8.76

3 weeks re growth	23.76	26.83	23.09	19.32	20.32	19.34	16.83	9.87
4 weeks re growth	25.71	24.38	23.77	20.09	20.73	19.26	12.79	10.63
Mature Stand	44.87	36.09	34.56	33.54	28.38	24.39	22.71	9.67
LSD	17.11	17.37	NS	NS	5.63	7.58	NS	4.37
Interaction								
G x S	NS	NS	NS	NS	NS	NS	NS	NS

Spear grass densities were significantly lower in plots treated with glyphosate immediately after slashing and the unslashed (mature stands). Speargrass shoot densities in the mature stands were similar. At Mokwa, similar trends were observed except at 6 and 12 WAS where shoot density in the unslashed plot was similar to plots treated after 2, 3, and 4 weeks after slashing. Shoot and rhizome fresh weights were not

significantly affected by the two rates of glyphosate at both locations; shoot and rhizome weights were greater in plots treated lower dose of glyphosate. Shoot and rhizome weights were higher in plots treated with glyphosate immediately after slashing or left unslashed compared to plots that had 2, 3 or 4 weeks of shoot re-growth except at Mokwa (Table 4).

Table 4: Effect of Rate of Gyphosate Application and Shoot Re growth on Fresh Weight (g/m^2) of *Imperata Cylindrica* Shoots Rhizome at Ilorin and Mokwa (Trial 111)

	Shoot fresh weight		Rhizome fresh weight	
	Ilorin	Mokwa	Ilorin	Mokwa
Gylphosate rate (kg ae/ha) (G)				
0.94	21.92	22.09	54.23	14.69
1.88	20.65	21.67	50.24	14.63
LSD	NS	NS	NS	NS
Stage of growth of spear grass before herbicide application (S)				
No growth	27.34	26.92	68.12	36.67
2 weeks re growth	18.72	18.78	30.66	23.78
3 weeks re growth	19.54	20.38	36.28	13.38
4 weeks re growth	22.94	20.43	41.37	15.43
Mature Stand	26.42	22.57	66.09	34.03
LSD	6.23	7.22	19.93	9.45
Interaction				
G x S	NS	NS	NS	NS

Trial 3

Speargrass density, shoot emergence and rhizome fresh weight were significantly

affected by stage of speargrass shoot re-growth (Table 5).

Table 5: Effect of Shoot Re growth and rate of Glyphosate Application on Shoot Density (no/m²) and Rhizome Fresh Weight (g/m²) of Imperata Cylindrica in Ilorin (Trial 111)

	Shoot Density		Rhizome Fresh Weight		Shoot Emergence
	Weeks after Herbicides	Application of			
Stage of shoot of spear grass before herbicide application (SA)	3	6	12	15	18
No growth	134	164	339	81	93
2 weeks re growth	74	110	255	55	65
3 weeks re growth	46	57	193	33	48
4 weeks re growth	40	47	127	27	40
Mature Stand	49	69	232	36	48
Sed	20.58	21.50	33.89	6.20	7.00
LSD (0.05)	47.46	49.59	78.07	14.30	16.14
Rate of Glyphosate application (RA)					
3.76kg ae/ha	42	51	148	26	35
2.82 kg ae/ha	52	71	181	35	45
1.88 kg ae/ha	61	77	217	42	54
0.94 kg ae/ha	76	99	256	50	62
0.00 kg ae/ha	113	143	346	77	92
Sed	5.55	8.68	11.48	2.79	3.21
LSD (0.05)	11.21	17.54	23.20	5.64	6.48
Interaction					
SA x RA	NS	*	*	NS	*

Shoot density and shoot emergence in plots which were burnt 8 WAS were significantly higher than in plots which were treated with Glyphosate immediately after slashing. However allowing re-growth of spear grass for 2 weeks or 4 weeks or leaving the speargrass unslashed before treatment

resulted in significantly lower number of shoot and weight of rhizome.

The interaction of stage of spear grass re-growth and dose of Glyphosate was significant. Shoot and rhizome weights were lower in plots treated with Glyphosate 3 or 4 weeks of shoot re-growth irrespective of dose of Glyphosate (Table 6).

Table 6: Interaction Effect of Shoot Re growth and Rate of Glyphosate Application on Shoot Density (no/m²) and Rhizome Fresh Weight (g/m²) of *Imperata Cylindrica* in Ilorin (Trial 111)

		Glyphosate Rate (kg ae/ha)				
Spear grass stage of growth		3.76	2.82	1.88	0.94	0.00
No growth		121	179	164	195	163
2 weeks re growth		51	77	99	145	177
3 weeks re growth		19	27	37	51	148
4 week re growth		22	25	31	44	113
Mature Stand		40	45	54	63	112
Sed				27.64		
LSD (0.05)				57.63		
No growth		235	273	355	390	444
2 weeks re growth		186	216	248	284	339
3 weeks re growth		92	145	156	240	336
4 weeks re growth		61	79	102	111	283
Mature Stand		164	193	223	253	327
Sed				40.90		
LSD (0.05)				86.56		
Shoot Emergence at 18 WAA						
Glyphosate Rate (kg ae/ha)						
Spear grass of growth		3.76	2.82	1.88	0.94	0.00
No growth		63	77	97	101	125
2 weeks re growth		41	56	65	75	88
3 weeks re growth		24	34	38	44	73
Mature Stand		32	36	42	49	91
Sed				9.50		
LSD (0.05)				19.61		

Discussion

Glyphosate application was ineffective on speargrass that was not slashed back also as the foliage was not actively growing due to senescence. Most of the foliage of the unslashed speargrass was dry and could therefore not have been receptive for herbicide. Avav (2002) has shown that the efficiency of herbicides on speargrass is reduced by age of the foliage

while Rioux *et al* (1974) reported that maturity of the foliage at the time of application could also affect Glyphosate activity. This situation could have resulted in reduced penetration of the leaves by the herbicide in addition to reduced photosynthetic efficiency of the leaves.

The population of speargrass shoot in treated plots decreased linearly as the dose of Glyphosate was increased. This agreed with Lum *et al.* (2005a) who reported

that, the efficacy of Glyphosate depend on the dosage and the time of application, young plants can be controlled using lower application rates of the herbicide (Dozier *et al.* 1998).

In this study, speargrass is well controlled by Glyphosate dose of between 1.88 – 3.76 kg ae/ha when it is actively growing after being slashed back. The optimal time for optimum effect of Glyphosate is between 3 – 4 weeks of foliage re-growth after slashing. Glyphosate effect is reduced when the foliage is not actively growing or when the leaves have senesced. It can be concluded that age of re growth of spear grass from slashing influences the efficacy of Glyphosate irrespective of the dose on its control.

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