EFFICACY OF AMETRYN HERBICIDES ON WEEDS IN RAINFED AND IRRIGATED SUGARCANE FIELDS IN SOUTHERN GUINEA SAVANNA ECOLOGY OF NIGERIA

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ABSTRACT

Field experiments were conducted in 2012 and 2013 in a southern Guinea savanna ecology of Nigeria to evaluate weed control efficacy of two ametryn formulations (Ametryn 90 WDG and Ametryn 500 SC) on sugarcane under rainfed and irrigated conditions. Application of 4, 5 and 6 litres/ha of ametryn 500 SC or 2, 3 and 4 kg/ha of ametryn 90 WDG had high efficacy on weeds and gave similar cane yield as compared to monthly hoe weeded plots in both trial fields. The highest dose of 7 litres/ha of ametryn 500 SC and 5Kg/ha of ametryn 90 WDG recorded the lowest cane yield. The best timing of weed control method using ametryn is post emergence application at 4 to 6 litres/ha of ametryn 500 SC and 2 to 4 kg/ha of ametryn 90 WDG but pre-emergence application of ametryn is not rule out. None of the ametryn formulations produced any phytotoxicity symptoms on the variety tested. No treatment gave really acceptable control of the Imperata cylindrica L. Raeuschel and Eleusine indica. L. Gaertn in both fields.

Key words: Ametryn, rate of application, time of application, sugarcane, rainfed, irrigation.

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INTRODUCTION

A major part of Africa lies in the tropics and sub-humid tropics which are characterized by high temperatures and humid ecosystems, a situation which makes the region conducive to weed growth. Hence, weeds constitute a significant component of the pest complex in African farms, consequently, an important constraint in agricultural production system (Takim and Amodu, 2013). Weeds act at the same tropic level as the crop; weeds capture a part of the available

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resources that are essential for plant growth (Pacanoski, 2006). Apart from the quantitative damages caused by weeds due to competition with water, light and nutrients as well as antagonism, weeds cause qualitative indirect damages due to crop yield reduction (Takim *et al*., 2012).

Sugarcane is an important crop in many African countries. In Nigeria, it is widely grown on a small scale for home consumption and on a large industrial scale for the manufacture of refined sugar and its byproducts (Ndarubu*et al*, 2006). Weed management becomes necessary to increase the sugarcane production and productivity to meet the burgeoning population but due to scarcity of labour, herbicide becomes the main option in sugarcane cultivation but the use of these herbicides for weed control now presents a challenge for the industry.

Nigeria is now a consuming nation of Paraquat, trazines, Butachlor and Glyphosate and this has induced imports of all kinds of generics of these products from certain countries in Asia. For instance, in late 1980-early 1990s about 80-85% of herbicides imported into Nigeria came from Europe and America and 15-20% from Asia. By 2010, 88-90% comes from Asia mainly China and India and 10-12% from Europe, USA and others, also interested to note that, about 97% of herbicides in Nigeria market were brand products in 1990 compared with 3% in 2011 (Onyibe and Shebayan, 2012).

With influx of new herbicides and different formulations of existing herbicides from different industries, these products should pass through series of experiments before recommended for commercial use;Firehun (2009) stated that for a pesticide to be used in any cropping system has to be tested for its effective rate and phytotoxicity effect on the crop. Hence, this study aimed at evaluating the efficacy of ametryn {(2-ethylamino)-4-(isopropylamino)-6-(methylthio)-*s*-triazine} herbicideson weeds and safety sugarcane inthe southern Guinea savanna of Nigeria.

MATERIALS AND METHODS

Trial I

Field experiments were established at the research farm of Josephdam Sugar Company, Bacita (9° 02ˈ34.80ˈˈ N; 4° 32ˈ 37.29ˈˈ E of Nigeria and is 298.09m above sea level. The experiment was designed as a randomized complete block with a split-plot arrangement where the main plots was time of application of herbicide (pre-emergence and post-emergence) as sub plots while the rate of application of herbicide [(i) Ametryn 500 SC: 2.0, 2.5, 3.0 and 3.5 kg ai/ha, (ii.) Ametryn 90 WDG: 2.0, 3.0, 4.0 and 5.0 kg ai/ha], hoe weeding @

monthly interval and Weedy control as the sub-sub plots and three replications.

The canes were planted in May (raining season) of 2012 and 2012 using B47419 as test variety. Three-eyed cane setts of 7 months old was laid horizontally end-to-end on 5 ridges of 8 m long per plot in three replications of 3042 m^2 that made up a total field size of 0.91 ha. The soil was well drained sandy loam soil.

The above procedure was repeated at the research farm of Unilorin Sugar Research Institute (USRI), Ilorin((9^o 16' 18.57'' N; 4^o 22' 12.05'' E) of Nigeria, and is 221.59 m above sea levelin November of 2012 and 2013 under irrigated fields.The soil was a sandy clay loam, classified as a *plinthustaffs*with approximately 74.12 % sand, 5.54 % silt and 20.69 % clay, organic matter 2 % and pH 5.5.

The mean of two years temperature and rainfall are shown in Fig. 1. *Imperata cylindrica* Raeuschel*, Tridax procumbens* L. and *Euphorbia heterophylla* L. dominated the irrigated field while *Eleusine indica* L.*, Bracharia lata* Schumach C.E and *Rottbolliacocin chinensis* Lour dominated the rainfed trial site (Table-1).

Data collection

Emergence count @ 30 days after planting (DAP), 9 weeks after planting (WAP),stand count at 16 WAP, tiller count @ 20, 30 and 40 WAP, stalk length, girth, internode length and number, brix, millable stalk and cane yield at harvest.Weed control index @ 3, 6, 9, 12 and 15 weeks after application of herbicide (WAA) using a scale of 0 to 5 (0 = no effect while 5= perfect control), weed density was estimated by counting emerged weed seedling within a 0.25 m^2 quadrat @ 3, 6, 9, and 12 WAA. The counted weed seedlings were pulledwithout ball of earth, dried to constant weight by natural sunshine and the dry biomass was obtained using digital weight balance.

Data Analysis

Data collected on efficacy on weeds, stand count at 16WAP and cane yield were subjected to ANOVA (α=0.05) using GenStat Discovery Edition 4 statistical package.

RESULTS AND DISCUSSION

Efficacy on weed

Time of application of herbicide significantly influenced the efficacy of ametryn (Table-2). The post emergence application had significantly higher weed control index than the pre-emergence application except at 3WAA. The efficacy of the pre-emergence application decreases with increased in WAA while the post emergence plots had high efficacy on weeds at 6WAA and sharply declined.

Rate of application of ametryn significantly affected the efficacy on weeds (Table-2). The MHW plots had statistically high weed control index at all assessment periods except at 3WAA while the weedy plots had relatively poor efficacy on weeds compared to other treatments. The SC formulation had lower efficacy on weeds where the highest dose (7Lof SC) was applied while WG formulation had relatively similar efficacy on weed at 3, 4 and 5kg of WG applied. The irrigated field had high numerical weed control index compared to rainfed field.

Time of application of herbicide significantly determined density of weeds (Table-4). The pre-emergence application had high weed density in all the periods of estimation and weed density increased gradually along periods of assessment while the post emergence plots had relatively low weed density and weed population declined at 6WAA then rapidly increased.

Rate of herbicide application influenced population of weeds significantly (Table-4). The higher doses of ametryn applied had relatively low weed density thought not statistically differed except with the monthly hoe weeded plots at 3WAA and weedy plots at all periods of assessment.

Time of herbicide application significantly affected weed dry matter production except at 3WAA in rainfed field (Table-4). Post emergence herbicide application had significantly lower weed weight than pre emergence plots. Monthly hoe weeded plots had significantly lower weed weight while while most of the plots treated with herbicide had similar weed dry matter produced and significantly lower compared to what was obtained from weedy control plots.

Effect on Sugarcane growth and yield

Sugarcane plant population was not influenced by time of herbicide application; pre-emergence had more stands of canes in rainfed while in irrigated post emergence plots had high sugarcane population. Conversely, the rate of application of herbicide significantly affected the stands of sugarcane (Table-3). The monthly hoe weeded plots had significantly higher sugarcane population compared to weedy plots. The herbicide treated plots had relatively similar plant stand and these sugarcane stand counts were lower as the application dose increases.

The herbicide effects on the yield of sugarcane presented on Table-3. Time of application did not affect the yield of sugarcane but rate of ametryn application significantly affected cane yield. There was an increased in cane yield as the dose increases until a peak was obtained then a gradual decrease. The highest dose of 7 litres/ha of Ametryn 500 SC and 5Kg/ha of Amertyn 90 WDG recorded the lowest cane yield. Application of 4, 5 and 6 litres/ha of Ametryn 500 SC or 2, 3 and 4 kg/ha of Ametryn 90 WDG gave similar cane yield as compared to monthly hoe weeded plots in both trial fields.

With great concern on herbicide environmental side effects, public health and recently resistant weeds, optimal rate and right time of application is important (Zhang *et al*., 2013) while maintaining weed control at an acceptable level and minimising crop injury (Nurse *et al*., 2007) during chemical weed management programs. In post-emergence programs, the use of herbicides at reduced rates is one of the most important tools to limit herbicide input into the environment (Swanton and Weise, 1991), and could also lower the cost of weed control (Zhang *et al.*, 2013) in developing countries (Afridi and Khan 2014; 2015) .

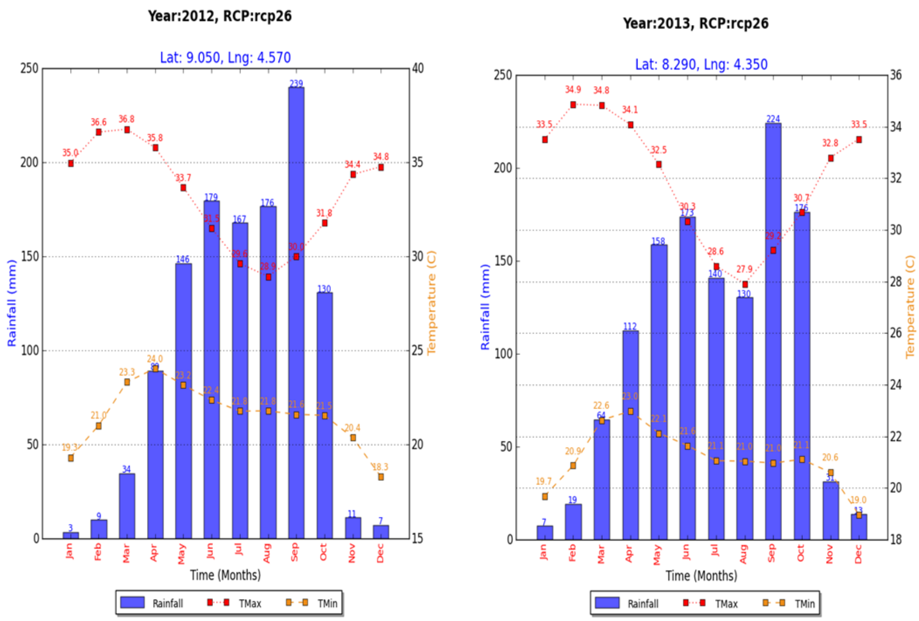
In this study, post-emergence ametryn application had low efficacy on weeds at 3WAA compared to pre emergence plots but the efficiency increased gradually to peaked at 6WAA then declined while pre-emergence application of the evaluated herbicide could not provide season long weed control because of their short persistence in the soil. Silva *et al.* (1999) reported that, persistence of some herbicides in the soil is extremely variable. Some herbicides may be degraded within few days, while others may persist for several months or years; however, the time that they remain active in the soil depends on edaphoclimatic conditions. The environmental fate of ametryn varies based on the site-specific properties of the soil to which it is applied. Based on packed soil column leaching studies, ametryn exhibit moderate to high mobility in most sandy to loamy soils, except for clay where its mobility is low. The major route of degradation of ametryn *per se* is aerobic soil metabolism, with an observed half-life range of 9.6 days to 38 days (USEPA, 2010).

The application of 4 to 6 litres/ha of ametryn 500 SC or 2 to 4 kg/ha of ametryn 90 WDG could relatively controlled broadleaf weed species and most annual grassy weeds except *Imperata cylindrica* and *Eleusine indica*. Under rainfed condition, 4 to 6 litres/ha of ametryn 500 SC had 30.90 - 33.80 ton/ha of canes while 31.00 – 36.50 ton/ha of cane was obtained in plots that had 2 to 4 kg/ha of ametryn 90 WDG. The irrigated field had relatively low cane yield, ametryn 90 WDG at 3-4 kg/ha yielded 31-26ton/ha while ametryn 500 SC at 4-6l/ha 27-23ton/ha.

It is suggested that, a supplementary application of any broad spectrum herbicide as directed spray at the label rate to control the emerged weeds after 6-7 WAP for pre emergence application or at 10-12WAP for post emergence application to control the emerged weeds or hoe weeding (depending on farm size) will effectively keep sugarcane field free of weeds for most of the vegetative growth stage and will subsequently translate into higher cane yield.

CONCLUSION

All the herbicides evaluated provided acceptable weed control and little or no crop injury. The best timing of weed control method using ametryn is post emergence application at 4 to 6 litres/ha of Ametryn 500 SC and 2 to 4 kg/ha of Ametryn 90 WG but the pre emergence application is not rule out. The formulations evaluated could be an effective alternative to sugarcane farmers and a supplement the existing sugarcane herbicides in the pesticide market.



Source: www.gismap.ciat.org (MarkSim DSSAT Weather file generator)

Figure 1. Mean rainfall and temperature at the experimental sites during the trial years

Table-1. Total density of weed species occurring in experimental fields

Weed Species	Irrigated Field Density (plants m^{-2})	Irrigated Field %	Rainfed Field Density (plants m^{-2})	Rainfed Field %
Amaranthus retroflexus L	12	0.55	9	0.45
Andropogon gayanus Kunth	19	0.87	116	5.82
Aspilia africana pers C.D. Adams	24	1.09	-	-
Axonopus compressus Sw. P. Beauv	73	3.34	198	9.94
Rottboellia cochinchinensis Lour	163	7.45	201	10.09
Bracharia lata Schumach C.E	101	4.62	230	11.55
Chromolaena odorata L (RM) Kings	17	0.78	8	0.40
Commelina diffusa Burm.	-	-	27	1.36
Cynodon dactylon (L) Pers	193	8.82	161	8.08
Cyperus esculentus L	-	-	56	2.81
Cyperus rotundus L	37	1.68	76	3.82
Desmodium salicifolium (Poir) DC	61	2.79	-	-
Eleusine indica (L.) Gaertn	172	7.86	423	21.23
Euphorbia heterophylla L	286	13.07	186	9.34
Euphorbia hirta L	71	3.25	-	-
*Imperata cylindrica*L Raeuschel	376	17.19	172	8.63
Mariscus alternifolius Vahl	92	4.21	24	1.20
Mariscus longibracteatus Cherm	63	2.88	-	-
Mitracarpus villosus Sw. DC	17	0.78	-	-
Physalis angulata L	29	1.33	-	-
Tridax procumbens L	381	17.42	105	5.27
Total	2187		1992	

Table-2. Effect of time and rate of application of ametryn formulations on and weed control efficiency

Treatment	Weed control index (scale: 0-5)						
	3WAA	6WAA	9WAA	3 WAA	6WAA	9WAA	12WAA
	Irrigated Field			Rainfed Field			
TIME (T)							
POST	3.60	5.53	4.30	2.9	3.2	2.5	1.7
PRE	5.47	3.34	2.23	3.9	2.1	1.2	0.6
LSD(0.05)	0.683	0.826	0.466	0.314	0.458	0.784	0.596
RATE(R)							
4L of SC	4.67	3.33	1.83	3.3	2.5	1.9	0.9
5L of SC	5.17	4.50	3.83	3.7	2.5	1.7	0.8
6L of SC	6.33	6.17	4.17	3.7	2.6	1.7	0.8
7L of SC	3.67	5.67	3.83	4.3	2.8	1.9	1.1
2kg of WG	4.67	5.33	4.00	3.2	2.3	1.1	0.6
3kg of WG	5.50	4.67	4.00	3.9	2.5	1.5	0.8

4kg of WG	5.17	4.67	4.83	4.1	3.0	2.3	1.5
5kg of WG	5.17	4.33	4.50	4.3	2.5	1.4	1.8
MHW	3.00	7.17	6.67	2.9	6.0	5.2	3.3
Weedy	1.00	0.00	0.00	0.9	0.0	0.0	0.0
LSD(0.05)	1.528	1.847	1.043	0.439	0.583	0.518	0.461
INTERACTION							
T x R	NS	NS	NS	NS	NS	NS	NS

WAA= weeks after application, POST= post emergence application, PRE= pre-emergence application, SC= ametryn 500 SC, WG= ametryn 90 WDG, MHW = monthly hoe weeding.

Table-3. Effect of time and rate of application of ametryn formulations on sugarcane establishment growth and cane yield

Treatment	Cane Stand (4WAP)		Cane yield @ Harvest (t/ha)	
Time	Rainfed	Irrigated	Rainfed	Irrigated
Pre	58	36	30.10	32.95
Post	50	41	31.32	28.64
LSD (0.05)	NS	NS	NS	NS
Rate				
4L of SC	67	54	30.90	27.22
5L of SC	71	39	31.40	23.42
6L of SC	51	40	33.80	23.13
7L of SC	37	27	25.71	15.16
2kg of WG	43	56	31.03	23.36
3kg of WG	52	51	33.00	31.93
4kg of WG	56	35	36.50	26.60
5kg of WG	38	22	30.81	19.47
MHW	83	40	36.51	30.62
Weedy	30	17	07.30	7.82
LSD(0.05)	16.40	12.41	4.54	8.58
Interaction				
Time x Rate	NS	NS	NS	NS

WAP= weeks after planting, SC= ametryn 500 SC, WG= ametryn 90 WDG, MHW = monthly hoe weeding

Table-4. Effect of time and rate of application of ametryn formulations on weed population and dry matter production

Treatment	Weed population(no/m^2)			Weed biomass (g/m^2)			Weed population(no/m^2)			Weed biomass (g/m^2)		
	3WAA	6WAP	9WAP	3WAA	6WAA	9WAA	3WAA	6WAA	9WAA	3WAA	6WAA	9WAA
TIME (T)			Rainfed Field						Irrigated Field			
POST	84	62	105	30.78	23.92	47.47	45	20	40	5.83	4.39	5.28
PRE	101	124	136	13.45	37.86	70.45	86	105	113	9.80	10.73	13.56
LSD(0.05)	5.08	27.94	15.42	NS	11.08	18.35	21.38	20.65	12.59	1.677	1.949	2.138
RATE(R)												
4L of SC	85	143	197	18.64	34.08	67.74	52	86	122	8.46	13.02	15.61
5L of SC	63	119	154	14.89	21.86	39.56	54	52	65	8.17	7.28	9.19
6L of SC	47	98	149	10.23	29.81	64.58	29	31	37	4.10	2.47	3.30
7L of SC	43	77	132	6.78	27.87	60.75	45	45	39	2.55	1.28	1.82
2kg of WG	102	124	168	21.17	26.38	54.87	57	55	82	8.71	5.58	8.12
3kg of WG	94	82	64	16.32	28.47	59.18	46	52	43	6.07	4.03	3.49
4kg of WG	66	51	29	9.48	23.87	49.60	38	42	37	2.97	3.09	2.72
5kg of WG	56	37	22	8.69	31.58	59.82	25	21	21	1.56	1.23	1.60
MHW	184	19	28	59.46	4.23	9.74	120	28	45	9.78	4.60	6.97
Weedy	169	182	265	55.72	80.87	123.18	189	266	280	25.14	33.03	41.38
LSD(0.05)	38.93	42.72	37.06	6.27	14.74	29.03	47.81	46.18	28.16	3.757	4.357	4.780
INTERACTION												
VT	NS	NS	NS	NS	NS	NS	*	NS	*	*	NS	*

DAP= days after planting, WAP= weeks after planting, WAA= weeks after application, POST= post emergence application, PRE = pre-emergence application, SC = ametryn 500 SC, WG = ametryn 90 WDG, MHW = monthly hoe weeding

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