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EFFECT OF FLUAZIFOPBUTYL AND ATRAZINE/METOLACHLOR (TANK MIXED) FOR WEED CONTROL IN SWEETPOTATO(IPOMOEA *BATATAS*) IN SOUTH EASTERN, NIGERIA

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ABSTRACT
Field studies were conducted at the research farm of the National Root Crops Research Institute (NRCRI), Umudike, south-eastern Nigeria in 2008 and 2009 cropping seasons, to determine the effect of herbicides and the economic implications of chemical weed control in sweetpotato using herbicides. The experiment was set up as a randomized complete block design (RCBD), with three replicates. Sweetpotato TIS 87/0087 was planted at a spacing of 0.3m x 1m on the crest of well prepared ridges. The treatment includes, Fluazifopbutyl at rates of 1.0kg ai/ha, 1.5kg ai/ha and 2.0kg ai/ha (recommended rate). Atrazine/Metolachlor 1.5kg ai/ha(tank mixed), mixture of Atrazine/Metolachlor + Fluazifopbutyl at rate 1.0kg ai/ha + 1.75kg ai/ha, Atrazine/Metolachlor 2.5 kg ai/ha, Atrazine/Metolachlor 3.5 kg ai/ha, Manual weeding and unweeded plots. Data on weed types and weed density were collected using two 1m x 1m quadrat. Yields were collected by 50kg weighing balance. Data collected were subjected to analysis of variance using the GLM procedure of SAS and significant differences among means were tested using FLSD at 5% level of probability. The result obtained over the two years showed that application of Atrazine/Metolachlor at rate 1.5kg ai/ha controlled broad leave weeds, sedges and grasses effectively and had lowest weed density when compared with the other herbicides application and hand weeding. It also gave the highest yield and monetary gain when compares with manual weeding. This technique will be of utmost benefit to the farmers as it gave excellent weed control.

Keyword: Sweetpotatoes, Weed, Herbicides Treatments, Economics.

INTRODUCTION
Sweetpotato (*Ipomoea batatas* (L) Lam) is an annual perennial herbaceous crop grown world wide. It is a creeper of the convolvulaceae family, and one of the world's most widely and valuable crops. Farmers in more than 100 countries in tropical, sub tropical and warm temperate areas rely on it for food. The crop can adapt to a widely ranged of environmental conditions in the tropics.

On a well managed soil the yield could be as high as 13t/ha (Horton *et al*, 1989). Sweetpotato ranks seventh amongst the world's major food crops. The crop has ceased to be a "back yard" crop or "gap filler". Survey reports in Nigeria show that production, marketing and utilization have expanded in the last decade beyond its traditional, central and riverine areas (Agboola, 1999) to almost all ecological zones in the country (Tewe, *et al*, 2001). Currently, Nigeria is ranked first as the largest producer of sweetpotato in Africa with annual output of 3.46 million metric tonnes (FAO, 2008). Globally, Nigeria is the second largest producer of sweetpotato after China leading (106,197,100 million metric tonnes) (FAO, 2008).

Sweetpotato has low input requirements, short growing period of 3- 4 months and high yielding potentials, especially under unfertile soil conditions than other root crops (Woolfe, 1992). According to Horton *et al* (1989), sweetpotato produced more edible energy and dry matter per hectare daily basis than any other crop. It contains vitamins, particularly vitamin A and minerals comparable to those of shoots are consumed directly (as fresh or processed food) and indirect (as animal feed) and has potential as a major sources of raw material for industrial purposes such as adhesive, textiles, paper, confectioneries, alcohol production as well as energy source of cell batteries (Kozai, *et al*, 1996, Woolfe, 1992).

Yield is arguably the most desired trait by sweetpotato farmer's (Laurie *et al*, 1999), and despite the high agronomic potentials of sweetpotato, being a short duration crop (3 - 4 months), its production is limited with number of production factors. Notably among them are weed competition for nutrient, leading to poor soil fertility and low yield (Unamma, 1984). This could give rise to roots of low quality and poor root market price. Therefore, these constraints could be addressed through application of herbicides. Although Sweetpotato has low input requirements, however, manual weeding also poses serious threat to increase to total net benefit to farmers. Thus, developing a better chemical weed control measures could improve on the overall benefits to the farmers. Hence, the objectives of the study are to determine the effect of herbicides and the economic implications of chemical weed control in sweetpotato using herbicides .

MATERIALS AND METHODS

The experiment was conducted in 2008 and 2009 at the research farm of the National Root Crops Research Institute (NRCRI), Umudike (05^0, 29N, 07^0, 31'E and 122 M above sea level). The area has a bimodal rainfall pattern with an annual rain between 2000-2500mm. Total monthly rainfalls and mean maximum and minimum temperatures, total number of rainy days and sunshine duration are shown in Table 1. The soils of the experimental sites in the two years of the experiments were disc ploughed, harrowed and ridged 1 meter apart. Soil samples were taken at the depth of 15cm for analysis before planting. The trial comprised two herbicides and their rates, which includes Fluazifopbutyl at rate 1.0kg ai/ha, Fluazifopbutyl at rate 1.5kg ai/ha, Fluazifopbutyl at rate 2.0kg ai/ha, Atrazine/Metolachlor 1.5kg ai/ha, mixture of Atrazine/Metolachlor + Fluazifopbutyl at rate 1.0kg ai/ha + 1.75kg ai/ha, Atrazine/Metolachlor 2.5kg ai/ha, Atrazine/Metolachlor 3.5kg ai/ha, Manual weeding and unweeded plots. Sweetpotato vines TIS 87/0087 variety obtained from vine tip of healthy stem portions were cut into four nodes sizes and planted at 30 cm along the crest of the ridges given a total plant population of 33,333 plants/ha. Herbicides were applied at spray pressure of 2.1 bar and overall spray volume was 250 litres ha^{-2}. The treatments were arranged in a randomized complete block design (RCBD) of 3 replications. Each plots measured 5m x 6m. NPK 15:15:15 fertilizers were basically applied at the rate of 400kg/ha. The crop was harvested at 4 months after planting (MAP).

Data collected were subjected to analysis of variance using the GLM procedure of SAS (1998) and significant differences among means were tested using Fisher's least significant difference (LSD) at 5% level of probability. For economic analysis, the data were collected from May to August each year ie from planting to point of sale using cost route approach. Data collected were on all the input and output resources for the production of sweetpotato tubers. Since the study was on comparative advantage on one enterprise over the other, the cost on land, farm tools depreciation and interest charges and other fixed input cost items were excluded from the analysis. Hence, the best analytical tool among other economic tools that fit well in this study is the Partial budget model. However, the variable costs on input per hectare collected include cost on land preparation, sweetpotato vines, cost of herbicides, inorganic fertilizer, and manual labour on all the operational activities performed in the course of the trial. The data collected were analysed using Partial budget model following (Alimi and Manyong, 2000; Ezedinma *et al.,* 2006; Ogbonna *et al.,* 2007). The model is expressed as follows;

$$NB = GB - TVC \quad \ldots \quad (1)$$

$$MRR = NB / TVC \quad \ldots \quad (2)$$

Where,
NB = Net benefit measured in naira, GR = Gross farm gate benefit, derived as yield of sweetpotato in tones per hectare multiple by the farm gate price measured in naira. TVC = Total Variable input costs of all resources used measured in naira and MRR = Marginal rate of return, derived as a ratio of the change in net benefits to change in total variable input costs between treatments measured in percentage.

RESULTS

Weather and Soil Characteristics

The monthly rainfall for 2008 and 2009 showed that Umudike has a characteristics bimodal rainfall distribution pattern with peak in May and October (Table 1). The total annual rainfall distribution was 141 mm and 127 mm. between 2008 and 2009, the monthly minimum temperature varied from 20^0C to 24^0C where as monthly maximum temperature ranges from 30^0C to 35^0C for both years, the hottest months were February/March in both years.

The soils of the experimental site for both years were texturally classified as sandy loam and acidic in reaction with medium organic matter content (Table 2). Nitrogen and potassium were low in both years while a moderate amount of phosphorus was found. The major weeds found in the experimental sites were mainly broad leaves, grasses and sedges (Table 3).

Herbicides application had significant ($P<0.05$) effects on average weed types and weed density in both years (Table 4). Application of Atrazine/Metolachlor 1.5kg ai/ha controlled broad leave weeds, grasses and sedges .The treatment had the lowest weed density when compared with other treatments. Application of herbicides significantly ($P<0.05$) affects averaged root yield t/ha and yield components (Table 5). However, application of Atrazine/Metolachlor 1.5kg ai/ha, had the highest root yield (8.0 t/ha), saleable root yield (7.2 t/ha), highest total root number (39178/ha) and saleable root number (301340 t/ha) when compared with other weed control treatments. Application of Atrazine/Metolachlor 1.5kg ai/ha, out yielded unweeded plots, which suffered sweetpotato yield losses of 53.3%.

The partial budget analysis for the production of sweetpotato under different weed control methods (Table 6) showed that Atrazine/Metolachlor 1.5kg ai/ha, gave the highest marginal rate of return per naira (₦6.15) and also had a comparative advantage over other treatments as income was ₦84, 467.00.

DISCUSSION

The results showed good control of weed types and weed density in both years. Application of Atrazine/Metolachlor at rate 1.5kg ai/ha controlled broad leaved weeds, grasses, and sedges with lowest weed density, when compared with hand weeding and unweeded treatment. This also resulted in high total root yield and yield components. The hand weeded plots showed high yield when compared with the unweeded plot.

Weeds are known to complete with crops for space, light, water and nutrient. This result is in corroboration with the work done by (Fadayomi, 1979) and Ayani *et al* 1984) which had all been noted to affect root of sweetpotato crop in unweeded plots.The yield loss recorded in the unweeded plots agrees with the findings of Obadoni and Remison (2006) on significant yield loss due to uncontrolled weed growth. In earlier studies Olunuga and Akobundu (1978) demonstrated that degree of weed infestation and subsequent crop yield reduction depend on the crop type, variety and population, weed density, cultural practices, soil type and rainfall pattern. The high marginal return per naira recorded on Atrazine/Metalachlor over hand weeding showed that weeding manually is expensive when compared it with chemical weed control. This is in corroboration with Alimi and Manyong (2000), Ezedinma *et al.* (2006) and Ogbonna *et al.* (2007), who reported the economic assessment of weed control using partial budget analysis.

CONCLUSION

Results from this study indicated that total yield (t/ha) was highest with Atrazine/Metolachlor at rate 1.5kg ai/ha than the other weed control treatments, it also controlled weed types and low weed density. The economic analysis also showed that Atrazine/Metolachlor at rate 1.5 kg ai/ha was higher in terms of monetary gain than hand weeding and other herbicides weed control methods. Therefore, this technique will be of utmost benefit to the farmers at it gave excellent weed control.

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Table 1: Monthly rainfall, sunshine hours and mean maximum and minimum temperature of the experimental sizes in 2008 and 2009 cropping seasons.

Months	---------------------------2008----------------------------------					----------------------------2009----------------------------				
	Rainfall days (mm)	Rainy days	Maximum temperature (^0C)	Minimum temperature (^0C)	Sunshine (hrs)	Rainfall days (mm)	Rainy days	Maximum temperature (^0C)	Minimum temperature (^0C)	Sunshine (hrs)
January	13.4	2	31	20	5.0	62.8	2	33	23	5.6
February	0.0	0	35	21	4.0	62.8	4	34	24	6.0
March	168.4	8	34	23	5.9	47.8	4	34	24	4.6
April	219.8	16	32	23	3.7	100.5	12	33	23	5.1
May	373.5	18	32	23	5.8	416.2	15	33	23	5.7
June	352.3	19	30	23	4.3	236.7	14	31	23	4.5
July	310.2	20	29	22	3.0	306.3	18	30	22	3.2
August	327.4	22	29	22	3.3	287.4	19	29	23	2.3
September	404.0	20	30	23	3.3	205.5	18	30	22	3.7
October	211.0	13	31	23	5.7	311.1	14	31	23	4.9
November	6.7	2	32	24	6.2	23.7	7	32	22	6.5
December	8.9	1	33	22	6.1	0.0	0	34	23	7.6
Total	2395.6	141				2058.8	127			

Table 2: Physico-chemical properties of the soils at the experimental sites in 2008 and 2009 cropping seasons.

Year	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Organic matter (%)**	**Phosphorus (mg/kg)**	**Potassium (Cmol/kg)**	**pH (H_20)**	**Nitrogen (%)**	**CEC ME/100(g)**
2008	17	12	79	2.65	16.2	0.10	5.11	0.05	5.82
2009	17	11	81	1.09	30	0.06	5.06	0.01	5.72

Table 3: Weed species found in the experimental sites in Umudike.

Weed species	**Family**
Broad leaves	
Euphorbia heterophylla (L.)	*Euphorbiaceae*
Euphorbia hirta (L.)	*Euphorbiaceae*
Talinum triangulare (Jacq willd)	*portulacaceae*
Chlomoleeana odorata (L.)	*Composite*
Ageratum conyzoide (L.)	*Asteraceae*
Aspillia africana (pers) CD Adams	*Asteraceae*
Tridax procumbens (L.)	*Euphorbiaceae*
Amaranthus spinosus	*Amaranthaceae*
Amaranthus hybridus (L.)	*Amaranthaceae*
Mimosa invisa (L.)	*Mimosaceae*
Commelina benghalensis (L.)	*Commelianaceae*
Grasses	
Eleusine indica Gaertn	*Poaceae*
Cynodon dactylon (L.) pers	*Poaceae*
Imperata cylindrical (L.)	*Poaceae*
Panicum maximum Jacq	*Poaceae*
Sedges	
Cyperus rotundus (L.)	*Cyperaceae*
Cyperus exculentus (L.)	*Cyperaceae*
Cyperus difformis	*Cyperaceae*

Table 4: Effect of herbicides on weed types and weed density at Umudike, South-eastern, Nigeria (means of 2008 and2009 combined).

Weed control treatments	**Rate (kg ai/ha)**	**------------Weed Types (No.m^{-2})------------**			**Weed density (No.m^{-2})**
		Broad leaves	Grasses	Sedges	
Atrazine/Metolachlor	1.5	2.50	1.92	0.32	4.00
Atrazine/Metolachlor	2.5	5.58	4.00	1.00	10.33
Atrazine/Metolachlor	3.5	4.33	5.30	0.98	11.21
Fluazifopbutyl	1.0	6.58	2.20	0.75	7.80
Fluazifopbutyl	1.5	3.40	3.31	0.41	12.30
Fluazifopbutyl	2.0	3.21	2.09	0.60	5.20
Fluazifopbutyl + Atrazine/ Metolachlor	1.0 + 1.75	4.00	3.48	0.91	6.43
Manual weeding	4 + 6 + 8 WAP	0.20	0.4	0.02	1.02
Unweeded	-	108.00	57	78	245
LSD (0.05)		4.95*	3.09*	0.87**	7.45

Table 5: Effect of herbicides on mean weed yield and yield components of sweetpotato in 2008 and 2009 at Umudike, South-eastern, Nigeria

Weed control treatments	**Rate (kg ai/ha)**	**--------Root Yield (t/ha)------**		**--------Root No/ha---------**	
		Total yield (t/ha)	**Saleable root yield (t/ha)**	**Total root No/ha**	**Saleable Root No/ha**
Atrazine/Metolachlor	1.5	8.0	7.2	39178	301340
Atrazine/Metolachlor	2.5	5.2	4.1	28990	21341
Atrazine/Metolachlor	3.5	5.8	5.0	25120	25460
Fluazifopbutyl	1.5	6.3	5.2	34345	20345
Fluazifopbutyl	2.0	6.7	5.8	33148	28203
Fluazifopbutyl	1.0	6.4	5.3	28290	21346
Fluazifopbutyl + Atrazine/ Metolachlor	1.0 + 1.75	6.0	5.4	31456	23570
Manual weeding	4 + 6 + 8 WAP	6.8	6.1	39284	29467
Unweeded	-	3.2	2.4	20560	18356
LSD (0.05)		3.8	3.5	12121.2	11304.4

Table 6: A partial budget for sweetpotato production under different weed control method at Umudike, South-eastern, Nigeria

Weed control treatments	**Rate (kg ai/ha)**	**Average yield (t/ha)**	**Gross benefit (N/ha)**	**Net benefit (N/ha)**	**Marginal rate of return**
Atrazine/Metolachlor	1.5	8.0	99162	84467	6.15
Atrazine/Metolachlor	2.5	5.2	65394	48269	1.37
Atrazine/Metolachlor	3.5	5.8	72576	53020	1.48
Fluazifopbutyl	1.0	6.4	95508	80958	5.82
Fluazifopbutyl	1.5	6.3	77994	61694	2.84
Fluazifopbutyl	2.0	6.7	98154	80104	4.84
Fluazifopbutyl + Atrazine/ Metolachlor	1.0 + 1.75	6.0	82152	62919	2.40
Manual weeding	4 + 6 + 8 WAP	6.8	79758	44908	0.40
Unweeded	-	3.2	40068	33643	-