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Varietal Response of Sweet Potato (*Ipomoea Batatas* L.) to Herbicidal Rate With Integrated Hoe Weeding in the Early Cropping Season in Abeokuta

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Abstract

Weed competition is basically one of the major constraints in sweet potato (*Ipomea batatas* L.) production leading to 48–100% yield reduction thereby threatening food security. The use of pre-emergence herbicide, integrated with hoe weeding in two sweet potato varieties was investigated at the Federal University of Agriculture, Abeokuta (FUNAAB) in 2020 and 2021 early cropping seasons. The experiment, consisting of two sweet potato varieties (UMUSP 2 and Solo gold) as main treatments. Pre-emergence herbicide [isoxaflutole (75g/l) + aclonifene (500g/l)] at 0.5, 0.6 and 0.7 kg a.i. /ha alone' or with one supplementary hoe weeding at 6 weeks after planting (WAP)]; a hoe weeded check (hoeing at 3, 6 and 9 (WAP) and a weedy control as sub treatments. It was laid out in a randomized complete block design with a split-plot arrangement with three replications. Data collected on weed cover score, weed dry matter production, growth, and root yield of the sweet potato varieties were subjected to Analysis of variance and significant treatment means were separated using Duncan Mutiple Range Test at P ≤0.05. The results showed that Solo gold variety had higher vine length, number of branches and number of leaves than UMUSP 2 variety and also produced higher root yield in both years. Furthermore, the recorded vine length (285.3 cm), number of leaves (338) number of branches and root yield (6.3 t/ha) obtained on plot treated with isoxaflutole + aclonifene at 0.75 kg a.i /ha plus hoe weeding in both years were higher than the treatments with manual hoe weeding. Similarly, cost benefit return of isoxaflutole + aclonifene at 0.75 kg a.i /ha supplemented with hoe weeding (1:2.3) was higher than the cost benefit return of 3 hoe weedings (1:1.9). Lower weed dry matter production was recorded on the herbicide treated plots with hoe weeding compared to plots with three hoe weedings. Therefore, isoxaflutole + aclonifene at 0.75 a.i kg/ha with supplementary hoe weeding at 6 WAP could be adopted in sweet potato production in Forest – Savanna Transition Zone of Nigeria.

Keywords: Cost benefit, herbicide, weed dry matter, weed species.

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Introduction

Sweet potato (*Ipomoea batatas* L.) is an important starchy food crop grown in the tropical and sub-tropical parts of the world. Sweet potato is a dicotyledon associated with Convolvulaceae family and ranks worlds' seventh most important food crop (Ahn *et al*., 2010); it is a potential energy contributor and considered as fifth essential crop (fresh weight basis) after rice, wheat, maize, and sorghum (Ndolo, Nungo, Kapinga, and Agili, 2007). Sweet potato is originated from Central America. It is grown in over more than 166 countries of the tropics, subtropics and warm temperate regions of the world. It is amongst the world most important, versatile and under-exploited food crops with more than 90 million tonnes in annual production, contributed mostly by Asian and African countries, especially China (FAOSTAT, 2020).

Weeds have been a problem in agriculture most especially crop production since about 10,000 BC (Avery, 2006), being the most important pest complex. Weeds cause qualitative indirect damages to crop, yield reduction, contamination of seeds, slowing tillage and harvesting practices. Often, the labour is too expensive causing many farmers to abandon weed control thereby resulting in very low yields. This is however, tedious, inefficient, time consuming and associated with high labour demands (Ogwuike *et al*., 2014; Datta *et al*., 2017). In addition, labour for manual weeding is scarce and often too expensive for the average farmer to afford (Adigun *et al*., 2017; Daramola *et al*., 2019). Consequently, farmers spend a large amount of time in weeding operation (Daramola *et al*., 2020). Smallholder farmers spend 50-70% of their total farm labour budget on weed control which is mostly by hoe-weeding.

In most farming communities, weeding is not done on time because labour is often very scarce during the early stages when control is essential (Chikoye *et. al*., 2005). Late weeding results in crop losses especially if it is done after the critical period of weed competition (30 DAP). Weeds have always represented one of the main limiting factors in crop production, responsible for a loss of 13.2% of agriculture production or about $75.6 billion per year (Pacanoski, 2006).

Weed management is a critical, costly and a major constraint to successful sweet potato production since weeds compete with the crop for nutrients, water and sunlight causing losses as high as 50–60% (Stall, 2010). Weed control is necessary during the first 2 months when plant growth is slow (Lewthwaite and Triggs, 2000). Timing of weed control is important because crops have critical periods during which weed competition affects yield and beyond which effects are not detrimental to crop growth and yield (Knezevic and Datta, 2015).

Weed management in Africa suffers from low use of herbicides and mineral fertilizers, in addition to lack of available labour for weeding, often resulting in delays that defer weeding beyond the period of critical weed interference (Nyamangara *et al*., 2014; Nyanga *et al*., 2012).

Some researchers have recommended the use of herbicides as being economical compared to mechanical weed control (Gianessi, 2014; Muoni *et al*., 2013). However, the over reliance on herbicides in developed regions has led to increased levels of resistance in certain weed species (Hull *et al*., 2014), making the use of herbicides more and more questionable now and in the future. This requires correct identification of the weeds, and a proper decision on which herbicides chemistry to use and at appropriate rate, to achieve successful control of the weeds. The objectives of this study were to : (i) Evaluate different herbicide rates and integration of manual weed control methods on weed control of sweet potato; (ii) Evaluate varietal response of sweet potato to weed control (iii) Evaluate economic advantage of weed control to sweet potato farmers.

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of Federal University of Agriculture, Abeokuta (FUNAAB) (7º 20´ N and 3º 23E). The experiment was carried out between May and September 2020 and 2021 in the Forest – Savanna Transition Zone of Nigeria. Two sweet potato varieties vines [Umusp 2 (white flesh) and Solo gold (orange flesh)], were sourced from International Institute of Tropical Agriculture (IITA).

The experiment was designed as randomized complete blocks and arranged in split plot with three replicates. The main treatments were made up of white and orange fleshed sweet potato variety (Umusp 2 and Solo gold), the sub treatments were made up of application of pre-emergence herbicides (isoxaflutole + aclonifene at different rates of 0.5, 0.6 or 0.7 kg a.i. /ha alone or with one supplementary hoe weeding at 6 weeks after planting (WAP), a hoe weeded check (hoeing at 3, 6 and 9 WAP) and a weedy control. The main plot size was 36 m × 7.8 m (280m^2) made up of ridges, approximately 1.0 m apart. Each year, the experimental site was sprayed with glyphosate at 2.5 kg a.i /ha and left for 14 days, and thereafter weed debris were removed before ploughing, harrowing and ridging (1.0 m apart) operations were carried out. This was followed by field layout. Sweet potato varieties Umusp 2 and Solo gold vines of 0.3 m long bearing at least four nodes were planted on the crest of the ridges at a spacing of 1.0m x 0.6m inter row and intra row spacing respectively immediately after field layout. Supplying of missing stands was done one week after planting (WAP). Weeding was done as stipulated in the treatments. Five plants were selected at random from each plot and tagged permanently for the assessments of growth parameters and net plot was harvested for yield parameters at 4, 6,8 and 12 weeks after planting. Data were collected on number of leaves, number of branches, vine length, number of tubers, and weight of tubers. Yellowing, drying of leaves, falling of leaves, and cracking of the soil indicated the maturity of the sweet potato at 4 months after planting. Sweet potato vines were cut at the surface after which the tubers were manually harvested using hoe. Data collected were subjected to Analyses of Variance (ANOVA) using GENSTAT statistical package and significant treatment means were separated by the Duncan Multiple Range Test at 5% probability level. Weed density and weed biomass were estimated at 6 and 9 weeks after planting (WAP) within $(0.5m)^2$ quadrat. Data collected on weed species composition were subjected to ecological analysis to determine the relative frequency, relative density and summed dominance ratio according to Wirjahadja and Pancho (1975).

a. Gross Margin (GM) = Total Revenue – Total Variable Cost
b. Net Farm Income = Gross Margin – Total Fixed Cost
c. Total cost of Production = Total variable cost + Total Fixed cost

Benefit cost ratio (BCR**)** =

$$\frac{\text{Total Revenue}}{\text{Total cost of production}}$$

Results and Discussion

Weed flora: In 2020, a total number of 18 weeds were encountered during the period of the experiment, out of which 17 were found on plots planted with UMUSP 2 and all the 18 were found on plots with Solo gold (Table 1). Out of the 18 weed species found, 13 species were broadleaves, 3 grasses and 2 species were sedges (Table 1). In 2021, a total number of 14 weeds were encountered during the period of the experiment, irrespective of potato varieties; Out of the 14 weed species found, 10 species were broadleaves, 3 grasses and 1sedge.

*Vine length***:** Plots with isoxflutole + aclonifene at 0.75 a.i kg/ha recorded the highest vine length at 6 WAP in 2020, 9 and 12 WAP in 2021 compared to other treatments except plots with 3 hoe-weeding (Table 2).

Number of leaves: In both years, sweet potato Umusp 2 produced higher ($p<0.05$) number of leaves than Solo gold at 3 and 6 WAP in 2020 and at 9 WAP in 2021. Interaction between sweet potato varieties and weed control methods was significant on number of leaves at 6 WAP in both years. Application of isoxaflutole + aclonifene at 0.75 a.i kg/ha on Umusp 2 variety resulted in the maximum number of leaves which was significantly higher than other treatment combinations in the cropping season (Table 3).

Weed dry matter: In both years, sweet potato variety has no significant influence on the total weed weight (Table 3). At 6 WAP, plots treated with isoxaflutole + aclonifene at all rates with supplemented hoe weeding produced total weed dry matter comparable to the lowest in 3 hoe weeding in 2020 and 2021. Broad leaf weed dry matter production at 9 and 12 WAP in both years followed the same trend as recorded at 6WAP in 2020 (Table 4).

Yield and yield components: The yield variables of sweet potato were significantly affected by potato variety in both years. In both years, Solo gold variety produced significantly higher marketable root yield and total root yield than Umusp 2, conversely, Umusp 2 produced higher non marketable root yield than the Solo gold (Table 5). Weed control methods had significant effect on root yield in both years (Table 5). In both years, application of 0.75 a.i kg/ha plus hoe weeding resulted in the highest total root yield, higher than other treatments except the plot with 3 hoe-weeedings. Interaction of potato varieties and weed control methods was significant on total root yield in both years, marketable yield in both years and non-marketable yield in 2021. Application of isoxaflutole + aclonifene at 0.75 a.i kg/ha plus hoe weeding on Solo gold variety resulted in the highest marketable yield in both years (Table 6 and 7), Generally, different weed control methods on Solo gold variety produced higher yield than those of Umusp 2.

Cost benefit ratio: The white fleshed sweet potato variety Umusp 2 with the application of isoxaflutole + aclonifene @ 0.75a.i kg/ha followed by one hoe weeding recorded the maximum net monetary return (#870,896.00) and comparable to treatment with 3 hoe weeding in 2020 and the highest benefit cost ratio (1:2.3) for both years. Also it was recorded that in both experimental years, the treatments with sole control measures had lower values in terms of net monetary value and benefit cost ratio compared to the integrated weed control measures. However, in the year 2021, sole treatment of isoxaflutole + aclonifene @ 0.75a.i kg/ha did better than the integrated measure of isoxaflutole + aclonifene @ 0.6a.i kg/ha with one hoe weeding. Also, it was noted in both years that sole control measure of 3 hoe weeding recorded higher net monetary value and benefit cost ratio compared to treatments with sole control measures of isoxaflutole + aclonifene application.Comparing the two experimental years, all treatment associated with control measures were more financially rewarding than weedy check with regard to net monetary value and benefit cost ratio.

In the year 2020, the maximum net monetary return (#837,670.24) was recorded with treatment of isoxaflutole + aclonifene @ 0.75a.i kg/ha followed by one hoe weeding closely followed by isoxaflutole + aclonifene @ 0.5a.i kg/ha and 0.75 kg a.i./ha without hoe weeding (#800,714.20). The highest benefit cost ratio (1:2.0) was recorded with isoxaflutole + aclonifene @0.5 a.i kg/ha comparable to treatment with isoxaflutole + aclonifene @0.75a.i kg/ha. However, of all the treatments with control measures, Solo gold variety with 3 hoe weeding treatment has lower turnover compared to others which were more remunerative than weedy check.The experiment showed that in the year 2021, Solo gold variety with the application of isoxaflutole + aclonifene @0.75a.i kg/ha followed by one hoe weeding recorded the highest net monetary value (₦766,571.00) with benefit cost ratio of (1:1.5) compared to other weed control measures. Comparing the two experimental years, all treatment associated with control measures were more financially rewarding than weedy check with regard to net monetary value and benefit cost ratio. Similar to result reported by The integrated weed control with application of herbicides at lower rate along with hand weeding found to prevent the weed shifts and herbicide resistance in weeds (Singh *et al.* 1999).

Table 1: Common weeds species found on the experimental site during the study and their level of infestation (LOI) in 2020 and 2021 early cropping season at Abeokuta

Weed species	Family	LOI 2020	LOI 2021
BROADLEAVES			
Acalypha fimbriata (Linn.)	Euphorbiaceae	-	+++
Ageratum conyzoides (L.)	Asteraceae	++	++
Amaranthus viridus (L.)	Amaranthaceae	++	+
Calopogonium mucunoides (Desv.)	Fabaceae	-	+
Celosia isertii (C.C.Towns.)	Amaranthaceae	-	+
Chromolaena odorata	Asteraceae	++	+
Cochorus olitorius (L.)	Malvaceae	+++	
Commelina benghalensis (L.)	Commenlinaceae	++	++
Croton lobatus (Linn.)	Euphorbiaceae	+	-
Euphorbia heterophylla (L.)	Euphorbiaceae	+++	-
Euphorbia hirta (L.)	Euphorbiaceae	+	-
Ipomoea Mauritania (Jacq.)	Convolvulaceae	+	-
Oldelandia corymbosa (L.)	Rubiaceae	+	-
Senna occidentalis (L.)	Fabaceae	+	+
Spigelia anthelmia (Linn.)	Loganiaceae	+	+
Talinum triangulare (Jacq.) Willd	Asteraceae	+	+++
Tridax procumbens (Linn.)	Asteraceae	+++	+++
GRASSES			
Brachiaria decumbens (Staph.)	Poaceae	-	+

Digitaria horizontalis Wild	Poaceae	+	+
Panicum maximum (Jacq.)	Poaceae	+++	+++
Rottboellia cochinchinensis (Lour.)	Poaceae	+	
SEDGES			
Mariscus alternifolius(Vahl.)	Cyperaceae	+	-
Cyperus rotundus (L.)	Cyperaceae	+	+

Low + Medium ++ High +++

Table 2: Effect of weed control methods on vine length (cm) of sweet potato varieties in 2020 and 2021 early cropping season

	Vine length (cm)							
	3 WAP		**6 WAP**		**9 WAP**		**12 WAP**	
Treatments	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
Potato Varieties (P)								
Umusp 2	31.6a	34.2	67.3a	72.8	104.2	107.8	210.3	196.2
Solo gold	31.3b	33.7	61.0b	56.5	104.3	113.0	212.5	198.2
SED	1.94	NS	1.41	NS	NS	NS	NS	NS
Weed Control Methods (W)								
Iso + aclo @0.5a.i kg/ha	33.7c	35.5b	59.0b	67.5bc	102.0c	119.8ab	203.9b	205.6a
Iso + aclo @0.6a.i kg/ha	35.3b	37.1b	64.9ab	68.4bc	109.9bc	135.8a	201.2b	211.6a
Iso+ aclo @0.75a.i kg/ha	31.4c	34.0c	62.9b	76.0a	105.5c	117.7abc	210.0b	229.1a
Iso+ aclo @0.5a.i kg/ha+1hw	44.4a	46.9a	59.0b	55.6d	111.4bc	98.3c	238.9b	209.6a
Iso+ aclo @0.6a.i kg/ha+1hw	27.2d	29.5d	69.9ab	66.2c	108.6bc	116.0abc	227.3b	200.2a
Iso+ aclo @0.75a.i kg/ha+1hw	38.4b	43.4a	77.5a	79.8a	128.6a	110.1bc	285.8a	210.0a
3 Hoe weeding	26.1d	28.1d	77.8a	76.0a	124.7a	135.7a	283.9a	231.3a
Weedy check	14.9e	20.4e	35.3c	32.1e	43.2d	49.7d	40.1c	80.0b
SED	2.76	3.00	6.20	4.24	7.47	9.26	20.82	20.47
Interaction								
P x W	4.14	4.46	67.30	72.80	NS	14.24	NS	NS

HW: Hoe Weeding; Iso + aclo: Isoxaflutole + aclonifene Means followed by the same letters are not significantly different using Duncan's Multiple Range Test

Table 3: Effect of weed control methods on number of leaves of sweet potato varieties at 3, 6, 9 and 12 WAP in 2020 and 2021 early cropping season

	Number of leaves (no/plant)							
	3WAP		6 WAP		9 WAP		12 WAP	
Treatments	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
Potato Varieties (P)								
UMUSP 2	30.7	32.94	77.8	68.12	153.1	123.60a	264.7	268.1
Solo gold	28.5	30.60	72.6	68.46	153.4	121.73b	259.8	240.0
SED	NS	NS	NS	NS	NS	0.12	NS	NS
Weed Control Methods (W)								
Iso + aclo @ 0.5l/ha	33.8a	35.8a	61.2b	55.3f	134.9b	120.3e	243.7d	257.4c
Iso + aclo @ 0.6l/ha	33.2a	35.2a	79.1a	75.8d	161.9ab	134.3d	268.5cd	272.5bc
Iso + aclo @ 0.75l/ha	31.9b	34.9b	87.8a	83.1ab	178.5a	150.1b	282.3c	234.3d
Iso + aclo @ 0.5l/ha+1hw	35.2a	37.8a	84.5a	85.3a	178.7a	141.7c	298.1bc	289.2b
Iso + aclo @ 0.6l/ha+1hw	32.3b	34.1b	81.8a	82.5bc	165.1a	124.2e	298.9bc	287.2b
Iso + aclo @ 0.75l/ha+1hw	34.3a	36.3a	83.8a	80.7c	170.8a	123.9e	336.1a	331.8a
3 Hoe weeding	22.9c	24.9c	91.3a	62.1e	185.3a	170.4a	317.0ab	320.8a
zero weeding	13.5d	15.3d	32.0c	21.1g	50.7c	16.5f	53.0e	39.4e
SED	2.43	2.35	5.75	1.00	13.52	3.33	14.69	9.05
Interaction								
P x W	NS	NS	NS	1.49	NS	4.41	NS	12.24

HW: Hoe Weeding; Iso + aclo: Isoxaflutole + aclonifene Means followed by the same letters are not significantly different using Duncan's Multiple Range Test

Table 4: Effect of weed control methods on total weed dry matter production of sweet potato varieties and in 2020 and 2021 early cropping season

	Total weed dry matter (kg/ha)					
	6 WAP		9 WAP		12 WAP	
Treatments	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
Potato Varieties (P)						
Umusp 2	155.7	169.5	250.2	306.4	434	497.2
Solo gold	137.1	153.2	275.8	286.4	464	494.2
SED	NS	NS	NS	NS	NS	NS
Weed Control Methods (W)						
Iso + aclo @0.5a.i kg/ha	116.7bcd	137.3cd	275.7b	291.0b	526.7b	568.3b
Iso + aclo @0.6a.i kg/ha	143.0bc	160.3bc	270.0b	297.7b	525.0b	551.0bc
Iso + aclo @0.75a.i kg/ha	153.3b	176.0b	272.3b	280.7b	489.7b	495.0c
Iso + aclo @0.5a.i kg/ha+1hw	106.7cd	122.7de	120.7c	197.7c	244.0c	278.3d
Iso + aclo @0.6a.i kg/ha+1hw	96.0d	100.ef	104.7cd	159.7cd	222.3c	258.0d
Iso + aclo @0.75a.i kg/ha+1hw	85.0d	84.0f	83.0cd	156.0cd	192.0c	227.0d
3 Hoe weeding	49.0e	48.7g	61.3d	115.7d	80.7d	125.7e
Weedy check	421.3a	461.7a	916.0a	873.0a	1308.7a	1462.7a
SED	35.6	24.34	48.2	50.75	82.2	67.85
Interaction						
P x W	NS	NS	NS	69.06	NS	107.85

HW: Hoe Weeding; Iso + aclo: Isoxaflutole + aclonifene Means followed by the same letters are not significantly different using Duncan's Multiple Range Test

Table 5: Effect of weed control methods on sweet potato total weight of roots, weight of marketable roots and weight of unmarketable roots in 2020 and 2021 early cropping season

	Total Root weight (kg)		Weight of unmarketable roots(kg)		Weight of marketable roots(kg)	
Treatments	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
Potato Varieties (P)						
Umusp 2	3.7b	3.7b	0.5a	0.7a	3.1b	2.9b
Solo gold	5.4a	5.4a	0.3b	0.3b	5.1a	5.1a
SED	0.09	0.02	0.16	0.05	0.07	0.03
Weed Control Methods						
Iso + aclo @0.5a.i kg/ha	4.7c	4.6cd	0.4	0.4bcd	4.3c	4.1d
Iso + aclo @0.6a.i kg/ha	4.5c	4.3d	0.4	0.5bcd	4.0c	3.7e
Iso+ aclo @0.75a.i kg/ha	4.5c	4.9c	0.3	0.58bc	4.3c	4.3c
Iso+ aclo @0.5a.i kg/ha+1hw	4.6c	4.8c	0.3	0.5b	4.3c	4.1d
Iso+ aclo @0.6a.i kg/ha+1hw	5.6b	5.5b	0.6	0.4bcd	4.9b	5.1b
Iso+ aclon @0.75a.i kg/ha+1hw	6.2a	6.3a	0.5	1.02a	5.6a	5.3a
3 Hoe weeding	6.0ab	5.5b	0.4	0.3bcd	5.6a	5.2a
Weedy check	0.2d	0.4e	0.1	0.2bd	0.02d	0.13d
SED	0.23	0.18	0.16	0.13	0.21	0.13
Interaction						
P x W	0.31	0.24	0.27	0.18	0.28	0.18

HW:Hoe Weeding;, Iso + aclo: Isoxaflutole + aclonifene Means followed by the same letters are not significantly different using Duncan's Multiple Range Test

Table 6: Interaction between sweet potato varieties and weed control methods on sweet potato number of leaves (no. /plant) at 6 WAP in 2020 early cropping season

	Sweet potato varieties	
Weed Control Treatments	**Umusp 2**	**Solo gold**
Isoxaflutole + aclonifene @ 0.5l/ha	64.2	58.3
Isoxaflutole + aclonifene @ 0.6l/ha	90.7	67.7
Isoxaflutole + aclonifene @ 0.75l/ha	103.7	72.0
Isoxaflutole + aclonifene @ 0.5l/ha+1hw	82.3	86.7
Isoxaflutole + aclonifene @ 0.6l/ha+1hw	88.3	75.3
Isoxaflutole +aclonifene @ 0.75l/ha+1hw	77.2	90.7
3 Hoe weeding	91.0	91.7
Weedy check	25.3	38.7
SED	7.7	

WAP: Weeks after planting; a.i/ha: Active ingredient/hectare; HW: Hoe Weeding.

Table 7: Interaction between potato varieties and weed control methods on number of leaves (no./plant) at 6 WAP in 2021 early cropping season

	Sweet potato varieties	
Weed Control Treatments	**Umusp 2**	**Solo gold**
Isoxaflutole + aclonifene @0.5l/ha	63.7	47.0
Isoxaflutole + aclonifene @0.6l/ha	92.3	59.3
Isoxaflutole + aclonifene @0.75l/ha	108.0	58.3
Isoxaflutole + aclonifene @0.5l/ha+1hw	83.0	87.6
Isoxaflutole + aclonifene @0.6l/ha+1hw	69.3	95.6
Isoxaflutole + aclonifene @0.75l/ha+1hw	66.5	95.0
3 Hoe weeding	108.0	58.3
Weedy check	45.6	78.6
SED	1.49	

WAP: Weeks after planting; a.i/ha: Active ingredient/hectare; HW: Hoe Weeding

Table 8: Effect of weed control methods on monetary returns of Umusp 2 sweet potato 2020 early cropping season at Abeokuta

Treatments	**VC (₦/ha)**	**FC (₦/ha)**	**TC (₦/ha)**	**TR (₦/ha)**	**GMR (₦/ha)**	**NMR (₦/ha)**	**B:C ratio**
Iso + aclo @ 0.5l/ha	302,225	69,875	372,100	562,454	492,579	190,354	1:1.8
Iso + aclo @ 0.6l/ha	305,205	69,875	375,080	471,736	401,861	96,656	1:1.6
Iso + aclo @ 0.75l/ha	307,145	69,875	377,020	453,592.5	383,717	765,72.5	1:1.5
Iso+aclo@ 0.5l/ha+1hw	362,225	69,875	432,100	598,742	528,867	166,642	1:1.7
Iso+aclo@ 0.6l/ha+1hw	365,205	69,875	435,080	743,890	674,015	308,810	1:2.0
Iso+aclo@ 0.75a.ikg/ha+1hw	367,145	69,875	437,020	870,896	801,021	433,876	1:2.3
3 Hoe weeding	457,345	69,875	527,220	870,896	801,021	343,676	1:1.9
Weedy check	247,345	69,875	317,220	10,886.22	-306,333	-631,421	1.0.02

VC = Variable Cost FC = Fixed Cost TR = Total Return TC = Total Cost GMR = Gross Marginal Return NMR = Net Monetary Return B C = Benefit Cost

Table 9: Effect of weed control methods on monetary returns on Umusp 2 sweet potato 2021 early cropping season at Abeokuta

Treatments	**VC (₦/ha)**	**FC (₦/ha)**	**TC (₦/ha)**	**TR (₦/ha)**	**GMR (₦/ha)**	**NMR (₦/ha)**	**B:C ratio**
Iso + aclo @ 0.5l/ha	372,100	69,875	441,975	544,261.67	474,386.67	102,286.67	1:1.2
Iso + aclo @ 0.6l/ha	375,080	69,875	444,955	564,419.53	494,544.53	119,464.53	1:1.3
Iso + aclo @ 0.75l/ha	377,020	69,875	446,895	665,208.73	595,333.73	218,313.73	1:1.5
Iso+aclo@ 0.5l/ha+1hw	432,100	69,875	501,975	907,102.67	837,227.67	405,127.67	1:1.8
Iso+aclo@ 0.6l/ha+1hw	435,080	69,875	504,955	744,419.53	674,544.53	239,464.53	1:1.5
Iso+aclo@ 0.75a.ikg/ha+1hw	437,020	69,875	506,895	1,169,154.67	1,099,279.67	662,259.67	1:2.3
3 Hoe weeding	527,220	69,875	597,095	1,028,050.00	958,175.00	430,955.00	1:1.7
Weedy check	317,220	69,875	387,095	120,947.07	51072.07	-266,147.93	1:0.3

VC = Variable Cost FC = Fixed Cost TR = Total Return TC = Total Cost GMR = Gross Marginal Return NMR = Net Monetary Return B C = Benefit Cost

Table 10: Effect of weed control methods on net monetary returns and benefit cost ratio of Solo gold sweet potato in 2020 early cropping season at Abeokuta

Treatments	**VC (₦/ha)**	**FC (₦/ha)**	**TC (₦/ha)**	**TR (₦/ha)**	**GMR (₦/ha)**	**NMR (₦/ha)**	**B:C ratio**
Iso + aclo @ 0.5l/ha	332,225.00	69,875.00	402,100	800,714.20	730,839.20	398,614.20	1:2.0
Iso + aclo @ 0.6l/ha	335,205.00	69,875.00	405,080	714,483.44	644,608.44	309,403.44	1:1.8
Iso + aclo @ 0.75l/ha	337,145.00	69,875.00	407,020	800,714.20	730,839.20	393,694.20	1:2.0
Iso+aclo@ 0.5l/ha+1hw	392,225.00	69,875.00	462,100	640,571.36	570,696.36	178,471.36	1:1.4
Iso+aclo@ 0.6l/ha+1hw	395,205.00	69,875.00	465,080	714,483.44	644,608.44	249,403.44	1:1.5
Iso+aclo@ 0.75a.kg/ha+1hw	397,145.00	69,875.00	467,020	837,670.24	767,795.24	370,650.24	1:1.8
3 Hoe weeding	477,345.00	69,875.00	547,220	739,120.80	669,245.80	191,900.80	1:1.4
Weedy check	267,345.00	69,875.00	337,220	12,318.68	-57,556.32	-324,901.32	1:0.0

VC = Variable Cost FC = Fixed Cost TR = Total Return TC = Total Cost GMR = Gross Marginal Return NMR = Net Monetary Return B C = Benefit Cost

Table 11: Effect of weed control methods on net monetary returns and benefit cost ratio of Solo gold sweet potato in 2021 early cropping season

Treatments	VC (₦/ha)	FC (₦/ha)	TC (₦/ha)	TR (₦/ha)	GMR (₦/ha)	NMR (₦/ha)	B:C ratio
Iso + aclo @0.5l/ha	392,100	69,875	461,975	660,431.20	590,556.20	198,456.20	1:1.4
Iso + aclo @0.6l/ha	395,080	69,875	464,955	648,637.60	578,762.60	183,682.60	1:1.4
Iso + aclo @0.75l/ha	397,020	69,875	466,895	672,224.28	602,349.28	205,329.28	1:1.4
Iso + aclo @0.5l/ha+1hw	452,100	69,875	521,975	613,256.80	543,381.80	91,281.80	1:1.2
Iso +aclo@0.6l/ha+1hw	455,080	69,875	524,955	672,224.80	602,349.80	147,269.80	1:1.3
Iso +aclo@0.75a.ikg/ha+1hw	457,020	69,875	526,895	766,571.00	696,696.00	239,676.00	1:1.5
3 Hoe weeding	547,220	69,875	617,095	742,985.10	673,110.10	125,890.10	1:1.2
Weedy check	317,220	69,875	387,095	13,092.30	-56,782.70	-374,002.70	1:0.0

VC = Variable Cost FC = Fixed Cost TR = Total Return TC = Total Cost GMR = Gross Marginal Return NMR = Net Monetary Return B C = Benefit Cost

Table 12: Interaction between sweet potato varieties and weed control methods on total weight of roots (t/ha) in 2021 early cropping season

	Sweet potato varieties	
Treatments	Umusp 2	Solo gold
Isoxaflutole + aclonifene @ 0.5l/ha	2.7	6.5
Isoxaflutole + aclonifene @ 0.6l/ha	2.8	5.8
Isoxaflutole + aclonifene @ 0.75l/ha	3.3	6.5
Isoxaflutole + aclonifene @ 0.5l/ha+1hw	4.5	5.2
Isoxaflutole + aclonifene @ 0.6l/ha+1hw	2.8	5.8
Isoxaflutole + aclonifene @ 0.75l/ha+1hw	5.8	6.8
3 Hoe weeding	5.1	6.7
Weedy check	0.6	0.1
SED	0.24	

WAP: Weeks after planting; a.i/ha: Active ingredient/hectare; HW: Hoe Weeding

Conclusion and Recommendation

From this study, Solo gold variety of sweet potato had better performance than UMUSP 2 in this agroecological zone as it produced higher marketable root yield than UMUSP 2 when isoxaflutole + aclonifene at 0.75 kg a.i./ha plus hoe weeding at 6 WAP. The economic analysis also showed that Solo gold variety treated with isoxaflutole + aclonifene at 0.75 l/ha plus hoe weeding at 6 weeks after planting gave higher monetary gain than hand weeding and other herbicides weed control methods. Therefore, this technique will be of utmost benefit to the farmers as it gave excellent weed control and recommended to farmers as the most profitable venture in this agro ecology.

References

Adeyemi, O. R., Adigun, J. A., Hosu, D. O., Fanawopo, H. O., Daramola, O. S., Osipitan, O. A. 2017. Growth and yield response of two lowland rice varieties (NERICA L-19 and WITA 4) as influenced by period of weed interference in the forest savanna agro ecological cone of Southwest Nigeria. *Nigeria Journal of Ecology* 16: 142-160.

Adigun, J. A., Lagoke, S. T. O. 2003. Weed control in transplanted rainfed and irrigated tomatoes in the Nigerian savanna. *Nigerian Journal of Weed Science* 16: 23-29.

Adigun, J. A., Kolo, E., Adeyemi, O. R., Daramola, O. S., Badmus, A. A., Osipitan, A. A. 2017. Growth and yield response of upland rice to nitrogen levels and weed control methods. *International Journal of Agronomy and Agricultural Research* 11: 92-101.

Ahn, Y. O., Kim, S. H., Kim, C. Y., Lee, J. S., Kwak, S. S., & Lee, H. S. 2010. Exogenous sucrose utilization and starch biosynthesis among sweet potato cultivars. *Carbohydrate Research*, 345(1), 55-60. 10.1016/j.carres. 2009.08.025.

Alam, M., Rana, Z., Islam, S. 2016. Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange-fleshed sweet potato varieties grown in Bangladesh. Foods 5, 64

Avery, A. A. 2006. Nature's Toxic Tools: The Organic Myth of Pesticide-Free Farming, Center for Global Food Issues, 78-98.

Chikoye, D., Udensi, U. E. and Lum, A. F. 2005. Evaluation of a new formulation of atrazine and metolachlor mixture for weed control in maize in Nigeria. *Crop Protection*, 24:1016-1020.

Daramola, O. S., Adeyemi, O. R., Adigun, J. A., Adejuyigbe, C. O. 2019. Row spacing and weed management methods influences growth and yield of soybean. *Agricultural Tropica et Subtropica*, 52: 59-71.

Daramola, O. S., Adeyemi, O. R., Adigun, J. A., Adejuyigbe, C. O. 2020. Weed interference and control in soybean as influence by row spacing in the transition zone of South West Nigeria. *Journal of Crop Improvement*, 34: 103-121.

Datta, A., Ullah, H., Ferdous, Z. 2017. Water Management in Rice. In: 'Rice Production Worldwide', B. S. Chauhan., K. Jabran and G. Mahajan (Eds), Springer, Singapore, p. 255.

FAOSTAT. 2020. *Food Agriculture and Organization (FAOSTAT)*. Retrieve from http://www.fao.org/faostat/en/#data/QC [Google Scholar]

Gianessi, L. 2014. Importance of Herbicides for Conservation Agriculture in Sub-Saharan Africa (Case Study No. 102). International Pesticide Benefits. Crop Life Foundation, Washington DC.

Knezevic S. Z. 2014. Integrated Weed Management in Soybean. In: Recent Advances in Weed Management, Chauhan, B. S., Mahajan G. (Eds), pp. 223-237.

Korieocha, D. S. 2001. Effect of Integrating Chemical and Manual Weed Control Methods on Sweet Potato Yield and Profitability in Nigeria. *Nigerian Agricultural Journal*. ISSN: 0300-368X Volume 52 Number 2 August 2021, pp. 331-338.

Lewthwaite, S. L. and Triggs C. M. 2000. Weed control in sweet potatoes New Zealand Plant Protection Society (Inc.) http://www.nzpps.org/terms_of_use.ht

Muoni, T., Rusinamhodzi, L., Thierfelder, C. 2013. Weed control in conservation agriculture systems of Zimbabwe: Identifying economical best strategies. Crop Prot, 53: 23.28. https://doi.org/10.1016/j.cropro.2013.06.002

Mwanga, R.O.M., Yencho, G.C. and Moyer, J. 2011. Diallel analysis of sweet potatoes for resistance to sweet potato virus disease. Euphytica, 128: 237-248.

Ndolo, P. J., Mcharo, T., Carey, E. E., Gichuki, S. T., Ndinya, C. & Maling'a, J. 2001. Participatory on-farm selection of sweet potato varieties in western Kenya. *African Crop Science Journal*, 9(1), 41-48. 10.4314/acsj.v9i1.27623

Ndolo, P. J. , Nungo, R. A. , Kapinga, R. E. , & Agili, S. 2007. Development and promotion of orange-fleshed sweet potato varieties in Western Kenya. In *Proceedings of the 13th ISTRC Symposium* (pp. 689-695).

Nyamangara, J., Mashingaidze, N., Masvaya, E.N., Nyengerai, K., Kunzekweguta, M.,Tirivavi, R., Mazvimavi, K. 2014. Weed growth and labor demand under handhoebased reduced tillage in smallholder farmers' fields in Zimbabwe. *Agric. Ecosyst. Environ*. 187, 146e154.

Nyanga, P. H., Johnsen, F., Kalinda, T. H. 2012. Gendered Impacts of Conser-vation Agriculture and Paradox of Herbicide Use Among Smallholder Farmer.

NRCRI, 2003. (National Root Crops Research Institute), Umudike, Nigeria Annual Report.

Oerke, E. C., Steiner, U. 1996. Abschtzung der Ertragsverluste im Maisanbau. In:Ertragsverluste Und Pflanzenschutz - Die Anbausituation Fr Die Wirtschaftlich Wichtigsten

Kulturpflanzen. German Phytomedical Society Serie, Eugen Ulmer Verlag, Stuttgart, pp. 63e79.

Ogwuike P., Rodenburg J., Diagne P., Afiavi R. Noameshie A., Amovin-Assagba E. 2014. Weed management in upland rice in sub-Saharan Africa: *Impact on Labor and Crop produc-tivity Food Security,* 6: 327-337.

Pacanoski, Z. 2006. Herbicide-Resistant Crops – Advantages and Risks. Herbologia 7 (1): 47-59.

Singh, S. J., Prasad, S. M. and Sinha, K. K. 1999. Effect of weed management and moisture regime on winter maize + potato intercropping system of north Bihar. *Journal of Farming System Research and Development* 5 (1&2): 23-26.