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Case Report

Evaluating Efficacy of Newly Introduced Herbicides Against Coffee Weeds at Jimma, Southwest Ethiopia

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Abstract: Weed is the major limiting factor of coffee production in Ethiopia. Weeds cause 65% coffee yield reduction in the country. Now a day, the expensiveness of weed management has been a principle issue in economic analysis of coffee production in Ethiopia. Herbicide weeding is a best management option in coffee production. Which can offer an advantage of taking less time, demanding less labor and avoid potential of diseases spread that causes during mechanical weed management practices. Thus, newly introduced herbicides verification trial was conducted in Jimma Agricultural Research Center, Agaro and Gera sub center on station in 2022 cropping season to evaluate the efficacy of newly introduced herbicides. The study consists two (2) newly introduced herbicides such as Wipe away (Glyphosate Potassium salt 665 G/SL) Afro (Glyphosate 48% SL) and Kalach 360 SL (Glyphosate 36% SL) as standard check and weedy control check. The herbicides effectively reduced weed density and provide good weed control efficiency compared with weedy control. Especially Afro well performed compared with standard check herbicide. Tested herbicides provided full control through season with single application equivalent with kalach 360SL standard check herbicides. Tested herbicides showed fully control of weed species between 21- 30 days after treatment application. Therefore, based on herbicides efficacy test result Wipe away (Glyphosate Potassium salt 665 G/SL) at 0.75 liter per hector within 200 liter water and Afro (Glyphosate 48% SL) at 3.5 liter per hector within 250 liter applied at active growth stages of major coffee weeds recommended for control weeds in coffee.

Keywords: Coffee, Herbicides, Wipe Away, Afro, Efficacy, Jimma

1. Introduction

Coffee (*Coffeaarabica* L.) is the backbone of the country's economy, which is the second major traded commodity following to Oil both in terms of volume and values [1] and thus plays a vital role in the balancing of trade between developed and developing countries. It accounts 70% of the foreign exchange earning, 10% of the government revenue and provides about 25% income for Ethiopia's population [2, 3]. Arabica coffee is the most widely consumed, dominating over 70% in volume of production and over 90% of trade value globally [4]. Coffee is deep-rooted in both the economy and culture of the country. Arabica Coffee is the major export crop in Ethiopia and its contribution to the national economy is tremendous. It is the leading commodity in Ethiopia's industry and foreign exchange earner from which millions of workers and growers derive their livelihood. Coffee production is affected by various constraints such as weed management, periodic pest and diseases, diminishing of soil capacity and adverse weather condition. Weeds are among the major factors limiting coffee production in the country. Weeds in coffee have been reported to reduce yield by 65% and can cause complete crop failure depending on the type of weeds, growth stage of coffee trees and the prevailing growth conditions [5].

Despite, majority of coffee farmers heavily depend on manual slashing and digging which encourage the multiplication and spread of the noxious competitive perennial weeds [6, 7]. Currently, expensiveness of weed management has been a principle issue in economic analysis

of coffee production particularly in large scale farm in Ethiopia. This is because of the weed species those are found as dominant and prevalent in the areas where they favorably and quickly re-appear within the season. Hence, uses of effective systemic herbicides for controlling deep seated rhizomes, bulbs and tubers and above ground running stolen of the perennial sedges and grass weeds is vital. Under such circumstance evaluation different herbicides with different groups & mode of action is essential. Herbicide weeding is an alternative to hand weeding in coffee production. It also can offer an advantage of taking less time, demanding less labor and avoid potential of diseases spread that causes during manual slashing and digging weed management practices.

Having above mentioned points the studies was conducted following Pesticide Testing guidelines developed by Ethiopian Institute of Agricultural Research (EIAR) to evaluate the efficacy of newly introduced herbicides such as: Wipe away (Glyphosate Potassium salt 665G/LSL), Afro (Glyphosate 48% SL) comparing with already registered herbicide Kalach 360 SL (Glyphosate 36% SL) as standard control for control perennial grasses, perennial broad leaves and annual grasses and broad leaves weeds in Coffee at Jimma Southwest, Ethiopia.

2. Materials and Methods

2.1. Descriptions of the Study Area

The study was conducted at Jimma Agricultural Research Center (JARC/Melko). JARC is found in Oromiya regional state in Jimma zone, Ethiopia, 360 km to southwest of Addis Ababa. It is located at 07°46''N latitude and 36°47'E longitude with an elevation of 1753 meter above sea level (masl) receiving average annual rainfall of 1572mm. The area experience has mean daily minimum and maximum temperature of 11.6°C and 26.3°C, respectively. The major soil type of the center is chromic nitosol and cambiosl of upland and fluvisol of bottom land [8]. Similarly, the study was conducted at Gomma (Agaro) and Gera districts of Jimma zone in southwestern Ethiopia (7°37′–7° 56′N and 36°13′–36° 39′E). The area receives an annual rainfall in the range of 1480 to 2150 mm, with the main rainy season between June and September. Mean daily minimum and maximum temperatures are 12°C and 28°C, respectively.

2.2. Experimental Materials and Procedure

Newly introduced herbicides verification trial was conducted in Jimma Agricultural Research Center, Agaro and Gera sub center on station in 2022/23 cropping season on single plot by considering location as replication. The experiment consist four (4) treatments such as Wipe away, Afro, Kalach 360 SLas standard check and weedy control check. The trial was laid down on naturally infested fields where the noxious perennial grasses, perennial broad leaf weeds perennial sedges and annual broad leaf weeds were abundantly growing on 10m × 15m (150 m^2) plot size.

Different weed data were collected through visual assessments of percentage control in comparison to the control (without herbicide application) plot [9]. Data on weed flora composition infesting the experimental fields before treatment application were recorded. Weed population was counted throwing a quadrate size of 1m × 1m area three times within plot and the weed categorized as perennial grasses, perennial sedges, perennial broad leaves and annual grasses and broad leave weeds. Percentage of Weed inhibition (PWI) was calculated using the following formula [10].

$$Perrcentageofweedinhibition(PWI) = \left(NWC - \frac{NWT}{NWC}\right) * 100$$

Where, NWC & NWT are number of weeds (m^2) in the weedy check and any particular treatment, respectively. Individual and general weed control evaluations (1-9 scale score), 1= no control and 9= (100% control) were determined through visual observation at 7^{th}, 14^{th} and 30^{th}days' after treatment application by considering growth reduction, foliar chlorosis, wilting and stunting during the time of assessment. Weed Control Efficiency (WCE) Weed dry weight was calculated based on the following formula [11, 12]. The higher WCE the better is the herbicide treatment.

$$WCE\ (\%) = \frac{Weedcountin\ Weedyplot - WeedcountinTreatedplot}{WeedcountinWeedyplot} * 100$$

OR

$$WCE = \frac{DMC - DMT}{DMC} * 100$$

Where DMC- Dry matter of weeds in control (un treated) plot, DMT- Dry matter of weeds in a treatment after 30 days of treatment by harvesting all weeds within 1m × 1m quadrant area at ground level three times per plot [13].

3. Summary of Results

3.1. Weed Infestation

In the experimental was conducted under field in different weed species belonging to the annual broad leaf, grasses and sedges and perennial broad leaf, sedge, and grass were recorded and identified. Consequently, thirty three (33) belonging to eighteen families (18) recorded during study across locations. With this ground twenty-seven (27), twenty seven (27) and twenty nine (29) weed species belonging to sixteen (16), fourteen (14) and fifteen families were recorded from Jimma, Agaro and Gera within the experimental fields irrespectively (Table 1). Among the recorded species 72.73%, 6.10%, 18.19%, and 3.03% were categories as broadleaved, sedge, grass and parasite respectively. This result is consistent with conclusion that these are the major weed species that are prevalence growing (infected) in coffee crops [14]. Similarly, in terms of their life cycles 42.42% perennial, 54.55% annual and 3.03% biennial recorded across experimental locations (Table 1).

Table 1. *Weed species recorded in the experimental fields across locations before treatment application.*

Scientific Name	Family	Common Name	Life cycle	Morphology	Lacations		
					Jimma	Agaro	Gera
Cyperuscyperiodes		Small flower ubrelasedg	Perennial	sedge			
Cyperusrotundus		Purple nutsedge	Perennial	sedge			
Digitaraiabyssinica		African coach grass	Perennial	Grass			
Echinocloacolona	Poaceace	Jungle rice	Perennial	Grass			
Paspalumcomjugatum		Bufallo grass	Perennial	Grass			
Snowdeniapolystachya		Ethiopian grass	Annual	Grass			
Cynodondactylon		Star grass	Perennial	Grass			
Hydrocotyle Americana	Apiaceae	Indian pennywort	Perennial	Broadleaf			
Brachariamutica	Poaceace	Para grass	annual	Grass			
Commelinabenghalensis	Commelinaceae	Tropical spiderwort	perennial	Broad leaf			
Urticadioica	Urticaceae	Stinging nettle (doobbii)	Annual	Broad leaf			
Ipome species	Convolvulaceae	Bindweed	perennial	Broad leaf			
Ageratum conyzoides		Goat weed	Annual	Broad leaf			
Bidenspilosa	Asteraceae	Black jack	Annual	Broad leaf			
Galinsogaparviflora		Gallant soldier/ potato weed	Annual	Broad leaf			
Conyzaalbida		Asthmaweed	Annual	Broad leaf			
Alternantherracaracasana	Amarathaceae	Paper thorn	Perennial	Broad leaf			
Capsella bursa-pastoris	Brassicaceae	shepherd's purse	Annual	Broad leaf			
Brassica tournefortii		African mustard	Annual	Broad leaf			
Plantagolanciolata	Plantagnaceae	Narrow leaf plantain	Annual	Broad leaf			
Portulacaoleracea	Portulacaceae	duckweed	Annual	Broad lead			
Cynoglossumlanceolatum	Boraginaceae	Hounds tongue	Biennial	Broad leaf			
Cuscutacampestris	Custaceae	Dodder	Annual	Parasitic			
Galiumaparinae	Rubiaceae	Cleavers/bedstraw/ catchweed	Annual	Broad leaf			
Celosia trigyna	Amarathaceae	Silver spinach	Annual	Broad leaf			
Lantana camera	Verbenaceae	Wild sage	Perennial	Broad leaf			
Polygonumarvensis	Polygonaceae	knotweed and knotgrass	Perennial	Broad leaf			
Corrigiolacapensis	Caryophyllaceae	strapwort	A/P	Broad leaf			
Trifoliumrepens	fabaceae	Clover /trefoil	Annual	Broad leaf			
Lipediumafricanus	Brassicaceae	peppercress	Annual	Broad leaf			
Rumexobtusifolius	Polygonaceae	broadleaf dock,	Perennial	Broad leaf			
Amaranthushybridus	Amarathaceae	Green Pig weed	Annual	Broad leaf			
Leucasmartinicensis	Lamiaceae	Bobbin weed	Annual	Broad leaf			

Species presence

3.2. Effect of Herbicides on Weed Density and Percentage of Weed Reduction

Weed population and percentage of weed reduction data after herbicides application presented in (Table 2). Current verification trial result indicated that weed population was affected due to herbicides application. Tested herbicides effectively inhibit weed density as compared with weedy check (Table 2). Accordingly weed density reduced from (457 to 13.7) and (444 to 11.33) and due to application of wipe away and Afro herbicides respectively which is almost similar result compared with (446 to 11.33) obtained from the plot treated with Kalach 360 SL. The lower weed density mean value 10 per $1m^2$ was recorded from the plot treated with Afro at 30^{th} day evaluation time after herbicide application across locations which is best performed than Wipe away and standard check Kalach 360 SL herbicide. Also, the highest weed density mean value (466 per $1m^2$) was recorded in the weedy check plots (Table 3). Moreover tested herbicides showed effectively inhibition percentage. As a result indicated weed reduction percentage mean value ranged from 32.39% - 97% and 49.10% - 97.45%, were obtained from plots treat with Wipe away and Afro herbicides respectively (Table 2). This result in lines [15] who reported chemical weeding in tea plantation is feasible and efficient in Rwanda.

Table 2. *Effect of herbicide on weed population (per $1m^2$) and percentage of weed reduction.*

Location	Time of weed population assessment per treatment																			
	Wipe away					Afro					Kalach 360 SL					Weedy control				
	BA	7^{th}	14^{th}	21^{th}	30^{th}	BA	7^{th}	14^{th}	21^{th}	30^{th}	BA	7^{th}	14^{th}	21^{th}	30^{th}	BA	7^{th}	14^{th}	21^{th}	30^{th}
Jimma	456	309	68	37	13.7	473	227	98	39	13	457	341	113	61	9	462	491	513	541	476
Agaro	433	301	55	16	12	461	228	103	23	9.3	429	317	122	67	11	453	465	489	493	481
Gera	481	317	156	73	19	397	223	161	64	11.7	452	301	139	77	14	484	478	473	533	486
Mean	457	309	93	42	13.7	444	226	121	42	11.33	446	320	125	68	11.33	466	478	492	522	481

BA= Before Application

3.3. Effect of Herbicide on General Weed Control

Current herbicides efficacy test result showed that tested herbicides effectively controlled the annual and perennial broad leaves, grasses and sedge weeds which predominantly infested the experimental plots across locations. As present herbicide verification result showed that all herbicides showed good performances on general weed control as compared with standard control herbicide.

The general weed control percentage mean value ranged (54.78% to 96.29%) and (52.85% to 98.33%) observed in the plots treated with Wipe away and Afro herbicides at 14th and 30th day evaluation time after herbicide application across locations which is almost similar with general weed control mean value (50.07% to 98.33%) obtained from the plots treated by Kalach 360 SL standard check herbicide (Table 3). As indicated in this efficacy test study Afro herbicide showed better performance than wipe away and similar with Kalach 360 SL herbicides. This might be both herbicides Afro and Kalach 360SL are the herbicides with similar active ingredient (Glyphosate) and have fully systemic nature, unlike Wipe away has different active ingredient and systemic with partial contact nature.

Table 3. *Mean Effect of Herbicides on General Weed Control.*

Location	Treatment Evaluation Time (Day)																	
	Wipe away						Afro						Kalach 360 SL					
	14th		21th		30th		14th		21th		30th		14th		21th		30th	
	Score (1-9)	%WC	Score (1-9)	%WC	Score (1-9)	% WC	Score (1-9)	%WC	Score (1-9)	%WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Jimma	5	55.78	6.75	75.00	9.0	100	4.75	52.78	6.5	72.22	8.8	97.78	4.5	50.0	7.0	77.78	9.0	100
Agaro	5	55.78	6.5	62.22	8.5	94.44	5	55.78	6.75	75	9	100	5	55.78	7.0	77.78	8.75	97.22
Gera	4.75	52.78	6.25	69.44	8.5	94.44	4.5	50	6.5	72.22	8.75	97.22	4.0	44.44	6.75	75.0	8.8	97.78
Mean	4.9	54.78	6.5	68.90	8.58	96.29	4.92	52.85	6.58	73.15	8.85	98.33	5.20	50.07	6.92	76.85	8.85	98.33

WC= weed control

3.4. Effect of Herbicides on Individual Weed Species

The effect of the tested herbicides on individual weed species was presented in (Tables 4&5). The present herbicides verification result showed that the tested herbicides effectively control perennial grasses, perennial broad leaf weeds and perennial sedges, biennial broad leaf and the annual broad leaf weeds in the experimental plots. As a result among tested herbicides wipe away and Afro herbicides started to show growth retardation, foliar cholrosis, wilting and stands performance reduction symptoms in average at 6 day after application on weed species found in experimental plots. Both tested herbicide provide full control of many broad leave weed species, particularly, weed species from Asteraceae, Amaranthaceae, and Boranginaceae families between 14 to 30 days after herbicide application. This is because; some broad leaf weeds have single tap root system, which required relatively shorter time of only a week long to exhibit the herbicidal effect while some species required a little long weeks about four weeks to completely controlled by herbicide. This was due to the complex underground root and aerial systems of most perennial weeds, and more days were required for the herbicide to fully travel through the root system and exhibit herbicidal activity. Accordingly tested herbicides provide individual weed control percentage mean value over locations ranged from (53.25% - 95.29%) and (54.04% - 97.54%) obtained from Wipe away and Afro herbicides respectively which is almost similar with the weed control mean value obtained from Kalach 360 SL standard check herbicide (Tables 4&5).

Table 4. *Mean effect of Wipe away herbicide on individual weed control over locations.*

Weed Species	Treatment Evaluation Time											
	Wipe away (Glyphosate Potassium salt 665G/LSL)						Kalach 360 SL (Glyphosate 36% SL)					
	14th Day		21th Day		30th Day		14th Day		21th Day		30th Day	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Cyperuscyperiodes	4.50	50.00	6.00	66.67	8.17	90.74	4.17	46.33	6.33	70.33	8.50	94.44
Cyperusrotundus	4.67	51.85	6.00	66.67	8.17	90.74	4.17	46.33	6.33	70.33	8.50	94.44
Digitaraiabyssinica	4.83	53.70	6.17	68.52	8.33	92.60	4.67	51.89	6.67	74.11	9.00	100.00
Echinocloacolona	5.00	55.56	6.00	66.67	8.83	98.15	4.67	51.89	7.00	77.78	9.00	100.00
Paspalumcomjugatum	5.00	55.56	6.17	68.52	8.67	96.30	5.00	55.56	7.00	77.78	8.83	98.11
Snowdeniapolystachya	4.33	48.15	6.17	68.52	8.67	96.30	5.17	57.44	6.67	74.11	8.83	98.11
Cynodondactylon	4.33	48.15	6.00	66.67	8.33	92.60	5.00	55.56	6.67	74.11	8.50	94.44
Hydrocotyle Americana	4.00	44.44	6.00	66.67	8.33	92.60	5.17	57.44	7.00	77.78	8.67	96.33
Brachariamutica	4.83	53.70	6.67	74.07	8.67	96.30	5.00	55.56	6.83	75.89	8.83	98.11
Commelinabenghalensis	5.33	59.26	6.50	72.22	8.67	96.30	5.33	59.22	7.17	79.67	8.83	98.11
Urticadioica	5.17	57.41	6.67	74.07	8.67	96.30	5.00	55.56	7.00	77.78	9.00	100
Ipome species	5.50	61.11	7.17	79.63	8.83	98.15	5.33	59.22	7.50	83.33	9.00	100
Ageratum conyzoides	5.17	57.41	6.50	72.22	9.00	100	5.33	59.22	7.33	81.44	9.00	100
Bidenspilosa	4.83	53.70	6.67	74.07	9.00	100	5.00	55.56	7.50	83.33	9.00	100
Galinsogaparviflora	4.83	53.70	7.17	79.63	9.00	100	5.67	63.00	7.17	79.67	9.00	100
Conyzaalbida	4.50	50.00	6.33	70.37	9.00	100	5.33	59.22	6.67	74.11	9.00	100

Weed Species	Treatment Evaluation Time											
	Wipe away (Glyphosate Potassium salt 665G/LSL)						Kalach 360 SL (Glyphosate 36% SL)					
	14th Day		21th Day		30th Day		14th Day		21th Day		30th Day	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Alternantherracaracasana	4.17	46.30	5.50	61.11	8.17	90.74	5.00	55.56	7.00	77.78	8.50	94.44
Capsella bursa-pastoris	5.17	57.41	6.17	68.52	8.50	94.44	5.67	63.00	6.83	75.89	9.00	100.00
Brassica tournefortii	5.50	61.11	6.83	75.93	8.67	96.30	5.67	63.00	7.17	79.67	9.00	100.00
Plantagolanciolata	4.83	53.70	6.33	70.37	8.33	92.59	5.17	57.44	6.67	74.11	8.50	94.44
Portulacaoleracea	5.50	61.11	7.00	77.78	8.67	96.30	5.33	59.22	6.67	74.11	9.00	100.00
Cynoglossumlanceolatum	5.17	57.41	7.00	77.78	9.00	100	5.50	61.11	7.00	77.78	9.00	100.00
Cuscutacampestris	4.83	53.70	6.50	72.22	8.50	94.44	5.50	61.11	7.17	79.67	8.67	96.33
Galiumaparinae	4.67	51.85	6.17	68.52	8.67	96.30	5.00	55.56	6.67	74.11	8.50	94.44
Celosia trigyna	4.50	50.00	6.00	66.67	8.17	90.77	4.17	46.33	6.33	70.33	8.50	94.44
Lantana camera	4.67	51.85	6.00	66.67	8.17	90.77	4.17	46.33	6.33	70.33	8.50	94.44
Polygonumarvensis	4.83	53.70	6.17	68.52	8.00	88.89	4.67	51.89	6.67	74.11	9.00	100.00
Corrigiolacapensis	5.00	55.56	6.00	66.67	8.83	98.15	4.67	51.89	7.00	77.78	8.83	98.11
Trifoliumrepens	5.00	55.56	6.17	68.52	8.67	96.30	5.00	55.56	7.00	77.78	8.83	98.11
Lipediumafricanus	4.33	48.15	6.17	68.52	8.67	96.30	5.17	57.44	6.67	74.11	8.83	98.11
Rumexobtusifolius	4.33	48.15	6.00	66.67	8.33	92.59	5.00	55.56	6.67	74.11	8.83	98.11
Amaranthushybridus	4.00	44.44	6.00	66.67	8.67	96.30	5.17	57.44	7.00	77.78	9.00	100
Leucasmartinicensis	4.83	53.70	6.67	74.07	8.67	96.30	5.00	55.56	6.83	75.89	8.83	98.11
Mean	4.79	53.25	6.33	70.32	8.58	95.29	5.03	55.85	6.86	76.27	8.81	97.91

WC% = Weed control percentage

Table 5. *Mean effect of Afro herbicide on individual weed control over location.*

Weed Species	Treatment Evaluation Time											
	Afro (Glyphosate 48% SL)						Kalach 360 SL (Glyphosate 36% SL)					
	14th Day		21th Day		30th Day		14th Day		21th Day		30th Day	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Cyperuscyperiodes	4.33	48.11	6.00	66.67	8.67	96.33	4.17	46.33	6.33	70.33	8.50	94.44
Cyperusrotundus	4.33	48.11	6.00	66.67	8.67	96.33	4.17	46.33	6.33	70.33	8.50	94.44
Digitaraiabyssinica	4.83	53.67	6.67	74.11	9.00	100	4.67	51.89	6.67	74.11	9.00	100.00
Echinocloacolona	5.00	55.56	6.50	72.22	8.83	98.11	4.67	51.89	7.00	77.78	9.00	100.00
Paspalumcomjugatum	5.33	59.22	6.17	68.56	8.67	96.33	5.00	55.56	7.00	77.78	8.83	98.11
Snowdeniapolystachya	5.00	55.56	6.17	68.56	8.67	96.33	5.17	57.44	6.67	74.11	8.83	98.11
Cynodondactylon	4.17	46.33	6.00	66.67	8.50	94.44	5.00	55.56	6.67	74.11	8.50	94.44
Hydrocotyle Americana	4.33	48.11	6.33	70.33	8.83	98.11	5.17	57.44	7.00	77.78	8.67	96.33
Brachariamutica	5.17	57.44	7.23	80.33	9.00	100	5.00	55.56	6.83	75.89	8.83	98.11
Commelinabeghalensis	5.17	57.44	6.83	75.89	8.67	96.33	5.33	59.22	7.17	79.67	8.83	98.11
Urticadioica	5.17	57.44	6.83	75.89	9.00	100	5.00	55.56	7.00	77.78	9.00	100
Ipome species	5.17	57.44	6.83	75.89	8.83	98.11	5.33	59.22	7.50	83.33	9.00	100
Ageratum conyzoides	4.83	53.67	6.17	68.56	9.00	100	5.33	59.22	7.33	81.44	9.00	100
Bidenspilosa	5.00	55.56	7.00	77.78	9.00	100	5.00	55.56	7.50	83.33	9.00	100
Galinsogaparviflora	5.00	55.56	7.00	77.78	9.00	100	5.67	63.00	7.17	79.67	9.00	100
Conyzaalbida	4.50	50.00	6.17	68.56	9.00	100	5.33	59.22	6.67	74.11	9.00	100
Alternantherracaracasana	4.17	46.33	5.83	64.78	8.67	96.33	5.00	55.56	7.00	77.78	8.50	94.44
Capsella bursa-pastoris	5.50	61.11	6.17	68.56	8.67	96.33	5.67	63.00	6.83	75.89	9.00	100.00
Brassica tournefortii	5.67	63.00	7.17	79.67	8.83	98.11	5.67	63.00	7.17	79.67	9.00	100.00
Plantagolanciolata	5.17	57.44	6.50	72.22	8.67	96.33	5.17	57.44	6.67	74.11	8.50	94.44
Portulacaoleracea	5.67	63.00	6.83	75.89	8.67	96.33	5.33	59.22	6.67	74.11	9.00	100.00
Cynoglossumlanceolatum	5.17	57.44	6.83	75.89	9.00	100	5.50	61.11	7.00	77.78	9.00	100.00
Cuscutacampestris	5.00	55.56	6.50	72.22	8.83	98.11	5.50	61.11	7.17	79.67	8.67	96.33
Galiumaparinae	4.33	48.11	5.67	63.00	8.17	90.78	5.00	55.56	6.67	74.11	8.50	94.44
Celosia trigyna	4.33	48.11	6.48	72.00	8.67	96.33	4.17	46.33	6.33	70.33	8.50	94.44
Lantana camera	4.33	48.11	6.00	66.67	8.83	98.11	4.17	46.33	6.33	70.33	8.50	94.44
Polygonumarvensis	4.83	53.67	6.00	66.67	8.67	96.33	4.67	51.89	6.67	74.11	9.00	100.00
Corrigiolacapensis	5.00	55.56	6.67	74.11	8.83	98.11	4.67	51.89	7.00	77.78	8.83	98.11
Trifoliumrepens	5.33	59.22	6.50	72.22	8.67	96.33	5.00	55.56	7.00	77.78	8.83	98.11
Lipediumafricanus	5.00	55.56	6.17	68.56	8.67	96.33	5.17	57.44	6.67	74.11	8.83	98.11
Rumexobtusifolius	4.17	46.33	6.17	68.56	8.67	96.33	5.00	55.56	6.67	74.11	8.83	98.11
Amaranthushybridus	4.33	48.11	6.00	66.67	8.83	98.11	5.17	57.44	7.00	77.78	9.00	100
Leucasmartinicensis	5.17	57.44	6.33	70.33	9.00	100	5.00	55.56	6.83	75.89	8.83	98.11
Mean	4.86	54.04	6.42	71.29	8.78	97.54	5.03	55.85	6.86	76.27	8.81	97.91

WC= weed control

3.5. Weed Control Efficiency

The current herbicides efficacy test result revealed that application of Wipe away and Afro herbicides provided excellent control on weed species found in experimental plots. This result is in line with Hassan et al. who reported a reduced weed biomass due to use of post emergences herbicides for controlling different weed species in experimental plots [16]. The study result showed that the herbicide both herbicides gave nearly similar weed control efficiency compared with the standard control Kalach 360 SL. Accordingly, the highest weed control efficient mean value over locations (97.66%) followed by (96.91) obtained from the plots treated to Afro and wipe away herbicides.

Table 6. *Herbicides weed control efficiency mean.*

Location	Treatments						
	Wipe away (Glyphosate Potassium salt 665G/LSL)		Afro (Glyphosate 48% SL)		Kalach 360 SL		Weedy Control
	Weed Population per $1m^2$	WCE (%)	Weed Population per $1m^2$	WCE (%)	Weed Population per $1m^2$	WCE (%)	Weed Populationper $1m^2$
Jimma	13.7	97.12	13	97.27	9	98.11	476
Agaro	12	97.51	9.3	98.10	11	97.71	481
Gera	19	96.10	11.7	97.60	14	97.12	486
Mean	14.9	96.91	11.33	97.66	11.33	97.65	481.00

WCE= weeds control efficiency

4. Conclusion and Recommendation

The herbicides efficacy test result clearly showed that application of Wipe away & Afro herbicides provided sufficient control of coffee weeds. These herbicides provided full control through season with single application equivalent with kalach 360SL standard check herbicides. Tested herbicides showed fully control of weed species between 21- 30 days after treatment application. Hence, based on above mentioned herbicide efficacy test result Wipe away (Glyphosate Potassium salt 665 G/SL) at 0.75 liter per hector within 200 liter water and Afro (Glyphosate 48% SL) at 3.5 liter per hector within 250 liter applied at active growth stages of major coffee weeds recommended for control weeds in coffee. Further studies are also recommended to evaluate the long-term effect the herbicides on soil health and non-target organisms to demonstrate the efficacy of new product on large scale coffee forming system, to determine the optimal dosage and application method suitable for different agro-ecological and coffee farming practices.

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Conflicts of Interest

The authors have no conflict of interest.

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