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Pre-Verification Trial of Bastnate plus Herbicide against Weeds in Coffee (*Coffea arabica* L.) at Jimma, Southwest Ethiopia

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Abstract

The newly introduced pre-verification trial of bastnate plus herbicide against weeds in coffee was conducted in Jimma agricultural research center, Agaro and Gera sub-center in 2022 cropping season to evaluate the efficacy of newly introduced chemicals and determine appropriate rate of bastnate plus compared with kalach 360 SL as a standard check. The experiment was laid out in a randomized complete block design with three replications. The treatments were consisted of bastnate plus at the rate of company recommendation 1L/ha, 50% above company recommendation 1.5L/ha, 50% below company recommendation 0.5 L/ha, kalach 360 SL as standard check and weedy control. The result revealed that application of bastnate plus at the rate of 1.5 L/ha effectively controlled annual, perennial and biennial broad leaves, grasses and sedge weeds in all locations. The higher weed control efficiency and lower weed population was recorded from the application of bastnate plus 1.5 L/ha than other bastnate rates but, almost similar with kalach 360 SL standard check. Therefore application of bastnate plus 50% above company recommendation (1.5 L/ha) with 250 Lt volume of water was recommended to proceed to the next verification stage against weeds in coffee.

Keywords: Bastnate plus; Chlorosis; *Coffea arabica* effect; Kalach 360 SL; Verification

Introduction

Coffee (*Coffea arabica* L.) is the mainstay of the nation's economy, which is the second most, traded good after oil in terms of both 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. Weeds are among the major factors limiting coffee production in the country. Yield loss due to weed competition estimated at 65% and can cause complete crop failure depending on the type of weeds, growth stage of coffee trees and the prevailing growth conditions [5]. However, most coffee growers still rely extensively on physical slashing and digging, which promotes the growth and spread of invasive competing perennial weeds [6,7]. Under these conditions, it is essential to employ systemic herbicides to eradicate perennial sedges and grass weeds above-ground runners as well as their deep-rooted rhizomes, bulbs, and tubers. Herbicide weeding is an alternative to hand weeding in coffee production. It can also offer an advantage of taking less time, demanding less labour and avoid potential of diseases spread that causes during manual slashing and digging weed management practices. As previously conducted research report indicated that wisely uses of herbicide reduce cost of weed control, increased crop yields by reducing weed competition and consequently increased profitability [8]. Previous herbicide pre-verification and verification trails conducted at Jimma Agricultural Research Center revealed promising results on weed control, providing better control than hand weeding and digging, and was recommended for registration and use in coffee production as one of the weed management options.

As a result efficacy and crop safety of bastnate plus, newly introduced herbicide was evaluated for control grass sedges and broad leaved weeds in coffee at Jimma, Southwest Ethiopia. Therefore the herbicide pre-verification trial was carried out in accordance with the pesticide testing guidelines created by the Ethiopian Institute of Agricultural Research (EIAR) to assure herbicide's weed control efficacy and determine appropriate rate compared with already registered and widely used herbicide Kalach 360 SL as standard check for control major weeds in coffee at Jimma, Southwest Ethiopia.

Materials and Methods

The trial was conducted in 2022 main cropping season at three locations at Jimma Agricultural Research Center (JARC), Agro and Gera sub center. The trial laid out on a naturally infested field where the major perennial grasses, broadleaf, sedges, and annual broad leaf coffee weeds are abundantly grown. The trail consist five treatments bastnate plus with company recommendation (1 L/ha), 50% lower (0.5 L/ha) and 50% higher (1.5 L/ha) than the company recommendation, Kalach 360 SL and un-treated or weedy control). A plot size of 6 m x 4 m (24 m2) was used at all locations. In order to encourage uniform and active growth of the weeds, all plots were slashed 30 days before treatment application. Knapsack sprayer fitted with flat fan nozzle will be used for herbicide application.

The type of weed species and their total cover of the experimental plots was recorded using 0.5 m x 0.5 m quadrate before treatment application. The average number of weeds counted from three quadrates and mean number of weeds per three was used at the end. The

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weeds were categorized as broad leaves weeds, Sedges and Grass weeds based on their leaf morphological characteristics. This was the way of determining weed density of the crop and efficiency of herbicides to control weeds. Accordingly to determine efficiency of herbicide weed control efficiency was calculated using the following formula.

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 50 cm x 50 cm quadrant area at ground level three times per plot.

Effect of herbicides on individual and general weed control was evaluated based on 1-9 scale score, where 1= no control and 9 = 100% control.

Individual and general weed control was determined by visual observation at the 7th, 14th and 30th days after treatment application by considering growth reduction, foliar chlorosis, wilting and stunting during assessments.

Results and Discussion

Weed infestation

Different weed species composing broad leaves, grass, sedges and parasitic weeds were observed in experimental fields. Twenty-four, twenty-three and twenty seven weed species belonging to fifteen (15), thirteen (13) and fourteen (14) families were recorded in Jimma, Agaro and Gera experimental fields respectively (Tables 1-4). The weed density was determined by categorizing them into broad leaf, grasses, sedge and parasitic weeds. Accordingly, 75%, 69.56% and 62.96% broad leaves, 12.5%, 21.74% and 29.93% grass weeds, 8.33%, 8.70% and 11.11% sedges and 4.17% parasite relative weed density were recorded from Jimma, Agaro and Gera site respectively. This result is agrees with who characterize and reported the major weeds species growing abundantly in coffee. Similarly, in terms of their life cycles 54.17%, 52.17% and 48.15% annual, 41.67%, 43.47% 48.15% perennial and 4.17%, 4.35% and 3.70% biennial weeds respectively recorded over location.3.2. Effect of Herbicide on Weed population and Percentages of Weed Reduction.

Table 1: Treatment Description.

Trt No.	Trade Name	Common Name	Application Rate (L/ha)	
			Herbicide	Water
1	Bastnate Plus as Company Recommendation (1L/ha)	Flumioxazin 1.5% + Glufosinate-ammonium 18.5% OD	1	200
2	Bastnate Plus 50% above Company Recommendation(1.5L/ha)		1.5	200
3	BastnatePlus 50% below Company Recommendation(0.5L/ha)		0.5	200
4	Kalach 360 SL	Glyphosate 36% SL	3	200
5	Weedy Control			-
Formulation: (conc. of *a.i* and type): 1.5%+ 18.5% OD (oil Dispersion)				
Formulator: -Shandong Weifang Rainbow Chemical Co., Ltd. Lvjian Road 03001, Binhai Economic Development Area, Weifang, Shandong, 262737, China.				
Mode of action: non_selective, contact with some systemic action. Induces accumulation of Prophyrins leading to membrane damage, inhibits photosynthesis.				

Table 2: Weed Species observed in the experimental fields at Jimma site.

Scientific Name	Family	Common Name	Life cycle	Morphology
Cyperus cyperiodes	Poaceace	Small flower ubrelasedg	Perennial	Sedge
Cyperus rotundus		Purple nutsedge	Perennial	Sedge
Digitarai abyssinica		African coach grass	Perennial	Grass
Echinocloa colona		Jungle rice	Perennial	Grass
Cynodon dactylon		Star grass	Perennial	Grass
Hydrocotyle Americana	Apiaceae	Indian pennywort	Perennial	Broadleaf
Commelina benghalensis	Commelinaceae	Tropical spiderwort	Perennial	Broad leaf
Ageratum conyzoides	Asteraceae	Goat weed	Annual	Broad leaf
Bidens pilosa		Black jack	Annual	Broad leaf
Galinsoga parviflora		Gallant soldier/ potato weed	Annual	Broad leaf
Conyza albida		Asthmaweed	Annual	Broad leaf
Alternantherra caracasana	Amarathaceae	Paper thorn	Perennial	Broad leaf
Capsella bursa-pastoris	Brassicaceae	shepherd's purse	Annual	Broad leaf
Brassica tournefortii		African mustard	Annual	Broad leaf
Plantago lanciolata	Plantagnaceae	Narrow leaf plantain	Annual	Broad leaf
Portulaca oleracea	Portulacaceae	Duckweed	Annual	Broad lead
Cynoglossum lanceolatum	Boraginaceae	Hounds tongue	Biennial	Broad leaf
Cuscuta campestris	Custaceae	Dodder	Annual	Parasitic
Galium aparinae	Rubiaceae	Cleavers/bedstraw/ catchweed	Annual	Broad leaf
Celosia trigyna	Amarathaceae	Silver spinach	Annual	Broad leaf
Lantana camera	Verbenaceae	Wild sage	Perennial	Broad leaf
Polygonum arvensis	Polygonaceae	knotweed and knotgrass	Perennial	Broad leaf
Corrigiola capensis	Caryophyllaceae	Strapwort	Annual	Broad leaf
Trifolium repens	Fabaceae	Clover /trefoil	Annual	Broad leaf

Table 3: Weed species observed in the experimental fields at Agaro.

Scientific Name	Family	Common Name	Life cycle	Morphology
Cyperus cyperioides	Poaceace	Small flower ubrelasedg	Perennial	Sedge
Cyperus rotundus		Purple nutsedge	Perennial	Sedge
Digitarai abyssinica		African coach grass	Perennial	Grass
Echinocloa colona		Jungle rice	Perennial	Grass
Paspalum comjugatum		Bufallo grass	Perennial	Grass
Snowdenia polystachya		Ethiopian grass	Annual	Grass
Cynodon dactylon		Star grass	Perennial	Grass
Hydrocotyle Americana	Apiaceae	Indian pennywort	Perennial	Broadleaf
Commelina benghalensis	Commelinaceae	Tropical spiderwort	Perennial	Broad leaf
Ageratum conyzoides	Asteraceae	Goat weed	Annual	Broad leaf
Bidens pilosa		Black jack	Annual	Broad leaf
Galinsoga parviflora		Gallant soldier/ potato weed	Annual	Broad leaf
Conyza albida		Asthmaweed	Annual	Broad leaf
Alternantherra caracasana	Amarathaceae	Paper thorn	Perennial	Broad leaf
Plantago lanciolata	Plantagnaceae	Narrow leaf plantain	Annual	Broad leaf
Portulaca oleracea	Portulacaceae	Duckweed	Annual	Broad lead
Cynoglossum lanceolatum	Boraginaceae	Hounds tongue	Biennial	Broad leaf
Galium aparinae	Rubiaceae	Cleavers/bedstraw/ catchweed	Annual	Broad leaf
Brassica tournefortii	Brassicaceae	African mustard	Annual	Broad leaf
Polygonum *arvensis*	Polygonaceae	knotweed and knotgrass	Perennial	Broad leaf
Lipedium africanus	Brassicaceae	Peppercress	Annual	Broad leaf
Amaranthus hybridus	Amarathaceae	Green Pig weed	Annual	Broad leaf
Trifolium repens	Fabaceae	Clover /trefoil	Annual	Broad leaf

Table 4: Weed species observed in the experimental fields at Gera.

Scientific Name	Family	Common Name	Life cycle	Morphology
Cyperus cyperiodes	Poaceace	Small flower ubrelasedg	Perennial	Sedge
Cyperus rotundus		Purple nut sedge	Perennial	Sedge
Cyperus esculentus		Yellow nut sedge	Perennial	Sedge
Digitarai abyssinica		African coach grass	Perennial	Grass
Echinocloa colona		Jungle rice	Perennial	Grass
Paspalum comjugatum		Bufallo grass	Perennial	Grass
Snowdenia polystachya		Ethiopian grass	Annual	Grass
Cynodon dactylon		Star grass	Perennial	Grass
Oplismenus compositus		Basket grass	Perennial	Grass
Bracharia mutica		Para grass	Annual	Grass
Hydrocotyle Americana	Apiaceae	Indian pennywort	Perennial	Broadleaf
Commelina benghalensis	Commelinaceae	Tropical spiderwort	Perennial	Broad leaf
Cerastium diffusum,	Caryophyllaceae	Sea mouse-ear,	Annual	Broad leaf
Bidens pilosa	Asteraceae	Black jack	Annual	Broad leaf
Galinsoga parviflora		Gallant soldier/ potato weed	Annual	Broad leaf
Conyza albida		Asthma weed	Annual	Broad leaf
Alternantherra caracasana	Amarathaceae	Paper thorn	Perennial	Broad leaf
Convolvulus arvensis	Convolvulaceae	Field bind weed	Perennial	Broad leaf
Capsella bursa-pastoris	Brassicaceae	shepherd's purse	Annual	Broad leaf
Brassica tournefortii		African mustard	Annual	Broad leaf
Plantago lanciolata	Plantagnaceae	Narrow leaf plantain	Annual	Broad leaf
Portulaca oleracea	Portulacaceae	Duckweed	Annual	Broad lead
Cynoglossum majora	Boraginaceae	Hounds tongue	Biennial	Broad leaf
Galium aparinae	Rubiaceae	Cleavers/bedstraw/ catchweed	Annual	Broad leaf
Polygonum *arvensis*	Polygonaceae	knotweed and knotgrass	Perennial	Broad leaf
Amaranthus hybridus	Amarathaceae	Green Pig weed	Annual	Broad leaf
Leucas martinicensis	Lamiaceae	Bobbin weed	Annual	Broad leaf

Total weed number of weed species present in 0.25 m2 area was counted before herbicide application and evaluated at 7th, 14th, 21th and 30th after herbicide application at all location. Bastnate plus herbicide affected weed population appeared in the experimental plots. The result indicated that different rates of Bastnate plus herbicide showed different performance on weed population reduction in experimental plots. As this result showed all rate performed well compared with standard check herbicide and weedy check. Accordingly, the highest weed reduction percentage ranged from 35.88%-98.30%, 44.53%-98.70%, and 33.71%-97.96% obtained from the plot treated with Bastnate plus

herbicide company recommendation (+50%) rate across the locations which is almost similar with 24.84%-99.57%, 29.15%-98.92% and 38.26%-98.48% result obtained from plots treated with standard check herbicide Kalach 360 SL.

The result described in table below showed that tested herbicide significantly inhibited the weed population within the evaluation time intervals in experimental plots across location. This result agrees with the result reported by [9] who confirmed that using herbicides leads to a significant reduction in weed density. Current study result indicated that the test herbicide Bastnate plus herbicide 1.5 L/ha has similar performance with Kalach 360 SL standard check herbicide compared with company recommendation (1 L/ha) and company recommendation minus 50% (0.5 L/ha) rate.

Effect of herbicide on general weed control

General weed control evaluation was conducted based on 1-9 scale at 7th, 14th, 21th and 30th days after herbicide application and percent weed control using score given during evaluation intervals. Bastnate plus herbicide effectively controlled the annual, perennial and biennia broad leaves, grasses and sedges weeds predominantly infesting the experimental plots at all locations. The test herbicide showed good weed performance on control of weeds appeared in experimental plots.

All rate of tested herbicide well performed on control weeds found within experimental field across location. 29.04%-84.44%, 35.22%-90.43%, 25.30%-80.25% and 20-95.37% weed control percentage mean value obtained at 14th and 30th after herbicide application from the plots received 1.0 L, 1.5 L, 0.5 L Bastnate plus herbicide and with standard check herbicide respectively across the locations (Tables 5 and 6). As indicated in this pre-verification result Bastnate plus herbicide 1.5 L/ha effectively control and provide highest general weed control percentage compared with standard check herbicide Kalach 360 SL.

Effect of herbicide on individual weed species

Bastnate plus herbicide pre-verification trial result revealed that tested herbicide effectively controlled all weed species infested experimental plots at all locations. Thus tested herbicide started to show growth retardation, foliar cholrosis, wilting and stands performance reduction symptoms on all weed species found in experimental plots between 4-7 days after herbicide application (Tables 7-9). Different rate of Bastnate plus herbicide showed different efficacy on weed species control.

Bastnate plus herbicide started react to weed control earlier than Kalach 360 SL and provide good efficiency control of major broad leave weed species similar with standard check herbicide between 21 to 30 days after herbicide application. This is because; Bastnate plus herbicide is partially similar with standard check herbicide in mode of action. That means Bastnate plus herbicide has non selective, contact with some systemic action which induces accumulation of prophyrins leading to membrane damage and inhibits photosynthesis. Among Bastnate plus herbicide rate used in this trial 1.5 L/ha effectively control weeds than other rate in experimental plot at all location which is almost similar with standard check herbicide.

Herbicide weed control efficiency

Bastnate plus herbicide effectively control the weeds infested the experimental plots at all locations. The study result indicated that all rate has good performance on weed control compared with weedy check and the standard check herbicide Kalach 360 SL. Among Bastnate plus herbicide rate used in this trail 1.5 L/ha provide excellent weed control efficiency which similar with standard check herbicide across location. The tested herbicide revealed 98.38% weed control efficiency mean value which is almost similar with the weed control average mean value 99.03% obtained from standard check herbicide across locations (Table 10).

Conclusion and Recommendation

The present pre-verification study revealed that the Bastnate herbicide effectively controlled the perennial, annual and biennial broad leaf, grass weeds and sedge weed species infesting coffee. The test herbicide gave full season protection with one time application. Company recommendation plus 50% (1.5 l/ha) Bastnate plus herbicide showed similar efficacy with the standard check herbicide Kalach 360

Table 5: Effect of herbicides on weed population.

Treatments	Time of assessment per Location														
	Jimma					Agaro					Gera				
	BA	at 7th	at 14th	at 21th	at 30th	BA	at 7th	at 14th	at 21th	at 30th	BA	at 7th	at 14th	at 21th	at 30th
Bastnate plus (1L/ha)	456	311	98	47	11	377	231	113	29	9	453	281	139	51	12
Bastnate plus (1.5L/ha)	471	302	73	36	8	384	213	97	21	5	442	268	125	37	9
Bastnate plus (0.5 L/ha)	463	307	106	53	13	379	251	115	37	11	457	293	173	61	15
Kalach 360 SL	463	348	137	30	2	367	260	117	13	4	460	284	162	53	7
Weedy check	459	487	473	487	461	382	388	380	372	389	459	451	447	471	490
BA= Before Application															

Table 6: Effect of Herbicide on General Weed Control (%).

	Time of assessment per Location																	
	Jimma						Agaro						Gera					
	at 14th		at 21th		at 30th		at 14th		at 21th		at 30th		at 14th		at 21th		at 30th	
Treatments	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
Bastnate plus (1L/ha)	2.17	24	5.6	62	7.8	87	2.5	27.8	5.67	63	7.5	83	3.17	35	5.8	65	7.5	83
Bastnate plus (1.5L/ha)	2.67	30	6.7	74	8.2	91	3.2	35.2	6.17	69	8	89	3.67	41	6.5	72	8.2	91
Bastnate plus (0.5 L/ha)	2.33	26	6.3	70	7.5	83	1.8	20.3	5.33	59	7.17	80	2.67	30	5.2	57	7	78
Kalach 360 SL	2.5	28	7.3	81	8.5	94	2.5	27.8	6.33	70	8.58	95	2.83	31	6.5	72	8.7	96
Weedy check																		

Table 7: Individual weed control efficiency of Bastnate Plus Herbicide at 30th evaluation time at Jimma site.

Weed Species	Treatment Evaluation Time							
	Bastnate plus (1L/ha)		Bastnate plus (1.5L/ha)		Bastnate plus (0.5L/ha)		Kalach 360 SL	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Cyperus cyperiodes	7.0	77.78	7.5	83.33	6.5	72.22	8.5	94.44
Cyperus rotundus	7.0	77.78	7.5	83.33	6.5	72.22	8.5	94.44
Digitarai abyssinica	8.0	88.89	8.33	92.56	7.33	81.44	8.25	91.67
Echinocloa colona	8.0	88.89	8.25	91.67	7	77.78	8.33	92.56
Cynodon dactylon	7.5	83.33	8	88.89	7	77.78	8.5	94.44
Hydrocotyle Americana	7.0	77.78	7.5	83.33	6.5	72.22	8.58	95.33
Commelina benghalensis	7.0	77.78	7.5	83.33	6	66.67	7.67	85.22
Ageratum conyzoides	9.0	100	9	100	9	100	9	100
Bidens pilosa	9.0	100	9	100	9	100	9	100
Galinsoga parviflora	8.5	94.44	9	100	9	100	9	100
Conyza albida	9.0	100	9	100	9	100	9	100
Alternantherra caracasana	7.5	83.33	7.5	83.33	6	66.67	8	88.89
Capsella bursa-pastoris	8.0	88.89	7	77.78	7.25	80.56	8	88.89
Brassica tournefortii	8.0	88.89	7	77.78	8.5	94.44	8	88.89
Plantago lanciolata	7.0	77.78	8	88.89	6.67	74.11	8.5	94.44
Portulaca oleracea	7.0	77.78	7.58	84.22	7	77.78	8	88.89
Cynoglossum lanceolatum	8.0	88.89	8.5	94.44	8	88.89	8.5	94.44
Cuscuta campestris	8.5	94.44	9	100	8.5	94.44	9	100
Galium aparinae	8.0	88.89	8.5	94.44	6.67	74.11	8.5	94.44
Celosia trigyna	7.5	83.33	8	88.89	7.5	83.33	9	100
Lantana camera	9.0	100	9	100	9	100	9	100
Polygonum arvensis	8.0	88.89	8.5	94.44	8	88.89	9	100
Corrigiola capensis	7.0	77.78	7.5	83.33	7	77.78	8.5	94.44
Trifolium repens	7.0	77.78	8	88.89	7	77.78	8.5	94.44
Mean	**7.81**	**86.81**	**8.11**	**90.12**	**7.50**	**83.30**	**8.53**	**94.83**

Table 8: Effect of Herbicide on Individual Weed Control at Agaro Research Site at 30 th day evaluation.

Weed Species	Treatment Evaluation Time							
	Bastnate plus (1L/ha)		Bastnate plus (1.5L/ha)		Bastnate plus (0.5L/ha)		Kalach 360 SL	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Cyperus cyperiodes	6.5	72.22	7.5	83.33	6	66.67	8.5	94.44
Cyperus rotundus	6.5	72.22	7.5	83.33	6	66.67	8.5	94.44
Digitarai abyssinica	7	77.78	7.5	83.33	6.5	72.22	8.58	95.33
Echinocloa colona	7.5	83.33	7.58	84.22	7	77.78	8.5	94.44
Paspalum comjugatum	7.5	83.33	7.5	83.33	7.33	81.44	8.5	94.44
Snowdenia polystachya	6.67	74.11	7.5	83.33	7.5	83.33	8.5	94.44
Cynodon dactylon	7.25	80.56	7.67	85.22	7	77.78	8.33	92.56
Hydrocotyle Americana	6.58	73.11	7.58	84.22	6.5	72.22	8.58	95.33
Commelina benghalensis	6.5	72.22	7.5	83.33	6.5	72.22	8.67	96.33
Ageratum conyzoides	9	100	9	100	8.5	94.44	9	100.00
Bidens pilosa	9	100	9	100	9	100.00	9	100.00
Galinsoga parviflora	8.25	91.67	8.83	98.11	9	100.00	9	100.00
Conyza albida	9	100	9	100	8	88.89	9	100.00
Alternantherra caracasana	6.58	73.11	7.67	85.22	6.5	72.22	8.33	92.56
Plantago lanciolata	6.33	70.33	7.5	83.33	6.25	69.44	8.17	90.78
Portulaca oleracea	6	66.67	7.58	84.22	6	66.67	8.33	92.56
Cynoglossum lanceolatum	8	88.89	8.5	94.44	8	88.89	8.5	94.44
Galium aparinae	8	88.89	8.5	94.44	7.5	83.33	8.58	95.33
Brassica tournefortii	8.5	94.44	8.83	98.11	7.58	84.22	8.83	98.11
Polygonum arvensis	8	88.89	8.5	94.44	7.67	85.22	8.5	94.44
Lipedium africanus	9	100	9	100	8.5	94.44	9	100.00
Amaranthus hybridus	9	100	9	100	8.83	98.11	9	100.00
Trifolium repens	7	77.78	8	88.89	6.5	72.22	9	100.00
Mean	7.55	83.89	8.12	90.21	7.31	81.24	8.65	96.09

Table 9: Effect of Herbicide on Individual Weed Control at Gera Research Site.

Weed Species	Treatment Evaluation Time							
	Bastnate plus (1L/ha)		Bastnate plus (1.5L/ha)		Bastnate plus (0.5L/ha)		Kalach 360 SL	
	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC	Score (1-9)	% WC
Cyperus cyperiodes	7.0	77.78	7.33	81.44	6.33	70.33	8.5	94.44
Cyperus rotundus	7.0	77.78	7.33	81.44	6.33	70.33	8.5	94.44
Digitarai abyssinica	6.67	74.11	7	77.78	6	66.67	8.83	98.11
Echinocloa colona	7.0	77.78	7.5	83.33	6	66.67	9	100.00
Paspalum comjugatum	7.5	83.33	8	88.89	6.67	74.11	8.58	95.33
Snowdenia polystachya	7.0	77.78	8.5	94.44	6.33	70.33	8.67	96.33
Cynodon dactylon	6.5	72.22	8.33	92.56	6	66.67	9	100.00
Oplismenus compositus	7	77.78	7.67	85.22	6.5	72.22	8.5	94.44
Bracharia mutica	6.5	72.22	7	77.78	6.17	68.56	8.58	95.33
Hydrocotyle Americana	6.67	74.11	7	77.78	6	66.67	8.5	94.44
Commelina benghalensis	7	77.78	8.33	92.56	5.5	61.11	8.33	92.56
Cerastium diffusum	7	77.78	7.5	83.33	7	77.78	9	100.00
Bidens pilosa	9	100	9	100	8.83	98.11	9	100.00
Galinsoga parviflora	8.5	94.44	9	100	8.5	94.44	9	100.00
Conyza albida	9	100	9	100	9	100.00	9	100.00
Alternantherra caracasana	7.5	83.33	8.17	90.78	6	66.67	8.67	96.33
Convolvulus arvensis	7.67	85.22	8.5	94.44	7.33	81.44	8.83	98.11
Capsella bursa-pastoris	7.5	83.33	8	88.89	7	77.78	9	100.00
Brassica tournefortii	8.5	94.44	9	100	8	88.89	5.5	61.11
Plantago lanciolata	6.5	72.22	8.83	98.11	6	66.67	8.5	94.44
Portulaca oleracea	6.5	72.22	7.5	83.33	6.17	68.56	8.5	94.44
Cynoglossum majora	9	100	9	100	9	100.00	9	100.00
Galium aparinae	8	88.89	8.5	94.44	7.5	83.33	9	100.00
Polygonum arvensis	8	88.89	8.67	96.33	8.33	92.56	8.5	94.44
Amaranthus hybridus	8.5	94.44	9	100	8.5	94.44	9	100.00
Leucas martinicensis	8.33	92.56	9	100	8	88.89	9	100.00
Mean	7.51	83.48	8.18	90.88	7.04	78.20	8.63	95.94

Table 10: Weed Control Efficiency of the Herbicide.

Treatments	Location					
	Jimma		Agaro		Gera	
	Weed population/1m²	Weed control Efficiency (WCE%)	Weed population per m²	Weed control Efficiency (WCE%)	Weed population per 1m²	Weed control efficiency (WCE%)
Bastnate plus (1L/ha)	11	97.61	9	97.68	12	97.55
Bastnate plus (1.5L/ha)	8	98.26	5	98.71	9	98.16
Bastnate plus (0.5 L/ha)	13	97.18	11	97.17	15	96.93
Kalach 360 SL	2	99.56	4	98.97	7	98.57
Weedy check	461		389		490	

SL on reduction of weed population, percentage general and individual weed control and weed control efficiency across locations within the season.

The test herbicide clearly showed its promising, result on growth retardation, foliar chlorosis, wilting and stands reduction symptoms on weed species infested experimental plots between 4-7 days after herbicide application and provide fully control between 21-30 days after treatment. This herbicide was found effective in providing weed free coffee throughout the season with one application per season. Thus, the present pre-verification result suggested that Bastnate plus herbicide at 1.5 L/ha with 250 L/ha water volume applied at active growth stage of target pest (weed) recommended to proceed to the next trial stage (verification) against weeds in coffee.

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