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Evaluation of Non Selective Post Emergence Herbicides against Complex Weeds at Arjo Dedessa Sugar Estate: Verification Trial

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Abstract

Four candidates of non-selective post-emergence herbicides were evaluated against complex weed management at Arjo Deddessa sugarcane estate. The evaluation was done based their efficacy and the experiment was laid in RCBD with three replications. The experiment was evaluated in rain fed condition up to 60 days after spray. The efficacy of the test herbicides shown that, all of the candidates except Trustsate 360 SL were control the broad and grass weed species up to 60 DAS without the supplement of additional control options. The candidates also provide good control efficacy to sedge weed species up to 40DAS. Generally, the test herbicides Linkosate 75.7 SG with efficacy level of 85.52%, Linkosate 48 SL with 84.14% and Getrid 480 SL with 78.44% were gave promising result against complex weed. Based on mean efficacy the three namely, Linkosate 75.7 SG, Linkosate 48 SL and Getrid 480 SL at Arjo Deddessa were effective to control citrus fields, mango orchard and other non-farms likes canal clearing with supplementing manual method for uprooting some weed species likes field bind weed and parthenium weed particularly according to their order. Arjo Deddessa sugarcane plantation can use these non-selective herbicides two weeks after spray before planting.

Keywords: Arjo; Fruit farm; Abadir; Orchard; Non-selective herbicides

Introduction

Herbicides are used extensively for weed control in crop production systems throughout the world. The Ethiopian sugar estates have been using non-selective herbicides in order to control weeds at harvest road, irrigation canals, reserve wires, citrus and mango orchards as well as to reduce tillage operations. However using of herbicides intensively for longer periods can affect the effectiveness of herbicides due to development of resistance by the weed species [**1**]. Herbicide resistance is an induced inherent ability of some plant species to survive and reproduce after receiving a lethal dose of herbicide [**2**]. Similarly others say that in plants, herbicide resistance is developed either by random mutation or it is self-induced by genetic engineering. In contrast herbicide tolerance can be defined as the inherent ability of plant to survive and reproduce with herbicide treatment at a normal use rate [**3**]. Thus, searching for alternative and most effective herbicides from efficacy and cost advantage point of view is indubitable **(Tables 1,2)**.

Moreover, in order to use a pesticide at a commercial scale, the sugar industry has to follow the National Pesticide Registration and Control Proclamation No 674/2010. As per the Proclamation, for a pesticide to be registered and to be used at commercial level, its efficacy for the control of the intended pests should be tested or verified through domestic research by a research organization. In order to make sugarcane pesticide testing more systematic and well-organized the former Ethiopian Sugar Corporation (ESC) has developed Guidelines for Pesticide Testing and established a Pesticide Research Committee (PRC) for follow up and proper implementation of the Guideline **(Table 5)**. Accordingly, two chemical companies applied four candidates to ESC Research Development Center, Pesticide Research Committee (PRC) for the evaluation of Linkosate 75.7 SG, Trust sate 360 SL, Linkosate 48 SL and Getrid 480 SL in order to be registered by Pesticide Advisory Committee of the Ministry of Agriculture as the new products for commercial use. The PRC decided the above-mentioned herbicides to be tested for verification. The objective of this study was therefore, to verify and select effective non-selective post-emergence herbicides for the control of annual and perennial weeds on the orchard ,harvest road and Fallow field of the sugarcane plantations of Ethiopia.

Table 1: List of Treatments.

S/N	Herbicides	Common name (a.i)	Formulation	Rate/plot (87 m²)
1	Linkosate 75.57 G	Glyphosate-ammonium 75.7 %	Glyphosate-ammonium75.7%	26.1 mg
2	Trustsate 360 SL	Glyphosate 36%	Glyphosate 360g/ISL	43.51 ml
3	Linkosate 48 SL	Glyphosate-ammonium 48%	Linkosate 48% SL	43.51ml
4	Getrid 480 SL	Glyphosate IPA SALT	Glyphosate 480gai/ lt SL	26.1ml
5	Round Up SL	Glyphosate		43.51 ml

Materials and Methods

Description of the study area

Arjo Deddessa sugar estate owned Sugar development project, previously established by Al-Abesh Sugar factory is located in 8°30'to 8°40' N Latitude and 36°22' to 36°43' E longitude, with average altitude of 1350m above mean sea level. Administratively, it is found in Jima, East Wollega, and Ilu Ababora zones of Oromia Regional state, 380 Km from Addis Ababa [**5**].

The annual average minimum and maximum temperatures of

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Table 2: Efficacy of the Test Herbicides on Broad Leaved Weeds Management.

SN	Treatment	% weed control					
		10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
1	Linkosate 75.7 SG	97.75a	96.62a	90.70a	87.04a	74.74a	83.29a
2	Trustsate 360 SL	95.56a	89.49a	74.74b	67.49b	47.88c	68.89b
3	Linkosate 48 SL	97.09a	90.03a	85.77a	77.49ab	68.86b	78.83a
4	Getrid 480 SL	96.23a	93.79a	90.03a	78.10ab	68.13b	82.36a
5	Glyphosate	97.44a	94.34a	87.90a	84.42a	69.77b	79.06a
6	LSD	5.15	10.14	6.96	13.23	13.49	7.23
7	% CV	3.1	6.43	4.64	9.46	10.92	5.12
8	R-SQ	0.91	0.82	0.79	0.51	0.78	0.71
9	Mean	93.49	88.58	84.33	78.57	69.51	79.47

Table 3: Efficacy of the Test Herbicides on Grass Weeds Management.

SN	Treatment	% weed control					
		10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
1	Linkosate 75.7 SG	89.49a	92.84a	93.11a	85.67b	76.31ab	86.23a
2	Trustsate 360 SL	91.59a	93.39a	93.09a	87.09a	88.29a	84.67a
3	Linkosate 48 SL	90.74a	92.59a	94.82a	85.93ab	80.00ab	79.63a
4	Getrid 480 SL	88.89a	91.32a	88.54a	86.46ab	80.21ab	82.74a
5	Glyphosate	90.80a	88.89a	96.93a	90.42a	86.59a	88.51a
6	LSD	10.29	10.53	12.01	14.66	22.61	10.97
7	% CV	6.68	6.78	7.59	9.74	16.25	7.68
8	R-SQ	0.76	0.82	0.76	0.48	0.48	0.78
9	Mean	86.57	87.27	89.00	84.01	78.22	80.29

Table 4: Efficacy of the Test Herbicides on Sedge Weeds Management.

SN	Treatment	% weed control			
		10 DAS	20 DAS	30 DAS	40 DAS
1	Linkosate 75.7 SG	63.16a	57.90ab	94.74a	77.19a
2	Trustsate 360 SL	52.38b	38.10b	52.38bc	57.14a
3	Linkosate 48 SL	73.02a	71.43ab	76.19ab	74.60a
4	Getrid 480 SL	62.96a	50.10b	48.15c	66.67a
5	Glyphosate	70.51a	83.33a	82.05a	83.33a
6	LSD	20.85	37.52	27.02	37.86
7	% CV	22.27	34.18	20.73	29.24
8	R-SQ	0.25	0.43	0.66	0.19
9	Mean	65.25	61.70	73.27	72.79

Table 5: Mean percent weed control on complex-weed.

SN	Treatments	Mean
1	**Linkosate 75.7 SG**	**85.52a**
2	Trust sate 360 SL	74.37b
3	Linkosate 48 SL	84.14a
4	Getrid 480 SL	78.44a
5	Glyphosate	87.53a
6	Lsd (5%)	13.6
7	Cv(%)	13.4
8	R-square	0.36
9	Mean	81.8
9	Mean	65.25

Arjo-Deddessa Project are 20.5°C and 25.4°C, wind speed of the site fluctuates more or less throughout the year. The highest and the lowest mean daily wind run of 1.07m/s and 0.47m/s respectively are in April. The mean relative humidity of the project is 56.6% and 88.6% for minimum and maximum respectively. Maximum and minimum daily sun shine hours were 8.3 in November and 3.7 in July respectively. Annual rainfall of the area is estimated to be above 1400mm with main rainy months lasting from May to October.

Study [**4**] and design (WWDSE, 2007) report indicated that the dominant soil textural classes of the project are clay and heavy clay soils.

Experimental methods

The experiment was executed in 2018/19 cropping season in already established citrus and mango orchards of Arjo Deddessa sugar estate. The target pest is complex weed (grass, broad weed and sedge grass). The test herbicides were applied as post-emergence application (herbicide applied when the weed emerged and reached 3-5 leaf stage). The herbicides were applied manually by using knapsack sprayer with spraying volume of 25 capacities. The evaluation was done at 10 days interval for the consecutive 60 days after spray. All other cultural practices of the site were the same as recommended, except the weed control practice.

Design and treatments

The experiment was conducted using randomize complete design with three replications. A plot area of 5m*8.7m (43.5m2) was used. Roundup Ready® system based on glyphosate herbicide was used as a standard check. At Arjo sugar estates Round up is currently used non

-selective post emergency herbicide to control the complex weed in the peripheral area of sugar cane fields and fruit orchards.

Data collection methods

Data on number of individual weed species in each quadrant sample were collected until 50 and 60 days after application. The experiment was conducted both irrigated and rain fed condition at Metahara and Arjo sugar estates.

But, data collected at 50days was not included for the data analysis at Metahara and also for Arjo data collected at 50 and 60 days for sedge weed species were not included because of poor data quality as well as total data at Finchaa. The weed population count was made along the two diagonals (in an "X" pattern) of the plots from five points using 0.25m * 0.25m quadrants at every 10 days interval for two months after herbicides application. A total of five quadrants were used for data collections. Efficacy of the candidate herbicides was determined quantitatively by percent weed control in the treated plot in comparison with that of untreated plot as used in [**6**] indicated below.

Percent weed control = weed count on unweeded treatment – weed count on treated * 100

Weed count on unwedded treatment

Data analysis

Data were subjected to ANOVA using the MIXED procedure in SAS, with herbicide treatment

Means were separated using LSD MEANS at the 5% level of significance. Data from the non- treated control were not included in the analysis to improve variance homogeneity. Means were separated using LSD MEANS at the 5% level of significance **(Table 1-2)** . Data from the non- treated control were not included in the analysis to improve variance homogeneity.

Results and Discussion

Effect of non-selective post-emergence herbicides on broad leaved weeds management

The efficacy of the candidate herbicides were under the test on broad leaved weeds control 10 days after spray revealed that, there were non- significant differences among the treated plots at P≤ 5% level of probability. Similarly, the efficacy of test herbicides showed non-significant differences on their percent weed control potential 20 day after spray. This might be attributed that, the response of the test herbicides at early stage after spray not showing the level of persistence. On the other hand, the applied herbicides might also be depleted or absorbed by the target pest equally and regrowth or new emergence of the weed might also be not expected at this stage after spray **(Table 3)**.

The test herbicides show statistically significant differences only for one treatment Trust sate 360 SL a month after spray (30DAS) which gave relatively lower percent weed control potential (74.74%) as compared to the rest treatments. However this result is still in acceptable rage according to [**7**], that efficacy of the herbicides ≥ 70 % is regarded as satisfactory.

The highest percent weed control of the test herbicides 40DAS was recorded on plots received Linkosate 75.7 SG and the standard check Glyphosate. However, there was no statistically significant difference was observed between these treatments. On the other hand, plots received Getrid 480 SL and Linkosate 48 SL also showed good control potential and still enough to fall in acceptable percent weed control ranges.

In contrary plot received Trust sate 360 SL show poor performance in weed control efficiency which is percent weed control below the standard acceptable range ≥ 70 %. This is might be the effect of low persistence ability of the product implies supplementary control options. Percent weed control potential of the test herbicides 50DAS drastically decline except plot received Linkosate 75.7 SG which significantly recorded better percent weed control (74.74%). This is because; a presence of newly emerged weeds after spray need at this stage supplementary weed control options **(Table 4)**. Therefore, the above finding implies that chemical means of weed control should be supplemented with other weed management practices in order to insure better control.

Furthermore, those weed species that escape herbicidal management would be controlled and enables to prevent the development of herbicide resistant weeds [**8**]. In contrary the efficacy of the test herbicides revealed excellent weed control 60DAS except plot received Trust sate 360 SL unexpectedly.

Effect of non-selective post emergence herbicides on grass weeds management

The efficacy of the test herbicides at 10, 20 and 30 days after spray, were control the grass weeds effectively without showing statistical differences. Significant differences were observed among the herbicides were under the test fourteen days after spray (40DAS). Accordingly the highest percent weed control potential was recorded on the standard check Glyphosate and the candidate herbicide Trust sates 360 SL 90.42% and 87.09% respectively.

Moreover plots received Linkosate 48 SL and Getrid 480 SL also recorded comparable percent weed control potential with the standard check Glyphosate, even though they were statistically different from the check. On the other hand, plot received Linkosate 75.7 SG recorded lower percent weed control (85.67%) comparing to the remaining treatments. However, its potential weed control is still in acceptable range. On the other hand, statistically significant difference was observed among the weed control potential of the test herbicides at 50 days after spray. In accordance, plot received Trust sate 360 SL and the standard check Glyphosate showed the best weed control efficacy with percent weed control of 88.29% and 86.59% respectively. Similarly the remaining treatments also show good control efficiency without showing statistical significant difference.

All the candidate herbicides including the standard check glyphosate remain statistically non-significant in there weed control potential 60DAS which fall in acceptable standard percent weed control. These is a great opportunity to have such products control grass weeds up to two months with one application frequency without the supplement of additional control options.

Effect of non-selective post-emergence herbicides on sedge weeds management

Among the test herbicides on sedge weed control, plot received Trust sate 360 SL show statistically significant difference from the other treatments including the standard check at 10 days after spray (10DAS). Even though, the remaining treatments show non-significant differences, only the two treatments Linkosate 48 SL and the standard check Glyphosate control sedge in a better way with percent weed control of 73.02% and 70.51% respectively.

A statistically significant difference was also observed among the treatments at 20 days after spray. Accordingly, the highest percent weed control was recorded on plot received the standard check Glyphosate followed by Linkosate 48 SL, while the least percent weed control was recorded on plot received Trust sate 360 SL. However, those plots received Linkosate 75.7 SG and Getrid 480 SL were still below the acceptable rages of percent weed control.

Great variation was observed among the treatments a month after spray (30DAS). Each treatment show significant difference one from another on the basis of there percent weed control efficacy. Accordingly, plot received Linkosate 75.7 SG was recorded the highest percent weed control (94.74%) followed by the standard check Glyphosate (82.05%), while the least percent weed control potential was recorded on plots received Getrid 480 SL and Trust sate 360 SL.

Generally the two candidate herbicides Linkosate 75.7 SG and Linkosate 48 SL show weed control efficiency comparable to the standard check. Beside these herbicides used as an alternative to integrated with other weed management options. On the other hand, no significant difference was observed on the efficacy of the test herbicides at 40 days after spray (40DAS). However, plots received Linkosate 75.7 SG, Linkosate 48 SL and the standard check Glyphosate recorded the standard percent weed control efficacy against sedge weed species.

The average percent weed control of the test herbicides on complex weed revealed that all of the candidates were in acceptable ranges of percent weed control potential for the respective frequency after spray **(Table 4, 5)**. This implies that the performance of the test herbicides on individual weed species perform differently as compared to their cumulative effect.

Conclusion and Recommendation

Five different herbicides including standard check were evaluated as non-selective post emergency for the control of complex weed management at Arjo Deddessa Sugar Estate. All the candidates were gave promising result in controlling complex weeds in mango orchard and non-crop land.

Based on their efficacy the candidates Linkosate75.7SG at 3lt/ha, Linkosate 48 SL 5lt/ha and Getrid 480 SL at 3lt/ha were recommended as non-selective post emergent herbicides in Mango orchard, fallow land and on sugarcane fields before planting at Arjo Deddessa sugarcane plantation. Since planting is not undertaken for all furrow fields at a time which exposed to high weeds infestation. As a result, planting operation becomes inconvenient. Therefore, Arjo Deddessa sugarcane plantation can also use these non-selective herbicides two weeks after spray before planting. So the estates can select and use based on their current cost and availability of herbicides.

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