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Tank Mixtures of Selective Post Emergence Herbicides against Sugarcane Complex Weeds at Wonji-Shoa Sugar Estate

Amrote Tekle*, Tolessa Taye and Yonas Worku

Ethiopian Sugar Industry, Group Sugar Research Center, P.O. Box 2003-1000, Wonji, Ethiopia

Abstract

Tank mixtures of Master 480 SC and POWER 860 SL selective post emergence herbicides against complex sugarcane weeds were evaluated at Wonji-Shoa Sugar Estate to see their synergetic effect. Master 480 SC was combined at 1lt/ha and 1.5lt/ha with POWER 860 at 1lt/ha, 1.5lt/ha and 2lt/ha on a plot size of six furrows of 5 m length each. The experiment was carried out in RCBD design in factorial arrangement with three replications. Hand and Unweeded control plots were included in the trial to ease comparison. Efficacy of the candidate herbicides were determined both qualitatively and quantitatively and phytotoxicity effect was determined qualitatively. The candidate herbicides were found promising result on weed control efficiency both quantitatively and qualitatively. There was no severe crop injury due to the test herbicides reflected on yield. Therefore, the plantation can use the tank mixtures of Master 480 SC at 1lt/ha with POWER 860SL at 1lt/ha for the control of grass and broad weeds and also tank mixtures of Master 480 SC at1.5lt/ha + POWER 860SL at 1.5lt/ha for the control of grass and broad weeds as well as on a sugarcane field dominantly affected by sedge weed species.

Keywords: Herbicides; Mixture; Post emergence

Introduction

Weeds mainly affect sugarcane during the critical weed crop competition period which range between 27 and 50 days [**1**]. Weeds, besides competing for moisture and light also remove about four times nitrogen and phosphorus and two times potassium as compared to the crop during the first 50-days period of crop emergence [**2**]. Weeds interfere with sugarcane by shading emerging sugarcane shoots reducing tiller formation and survival. Some weeds also produce allelo chemicals which can also inhibit sugarcane growth [**3**].

Herbicide use in sugar industry is a common way of reducing weed problems. Different types of herbicides are used in a single production cycle to reduce broadleaf weeds, annual grasses and sedges. The grower would require several subsequent applications in order to fully control all weeds since the weeds are variable and require specific herbicides. This increases operating costs in terms of labour and is time wasting. Alternatively, herbicides can be combined in a tank mix which is applied in a single once off to control a wider weed spectrum. A single once-off application also ensures that the grower controls different weed species simultaneously with a single application increasing efficiency [**4**].

Applying two or more herbicides sequentially or as a tank mixture to crop production system is, a common practice aimed to improve the spectrum of weed control reduce production cost and/or prevent the development of weed that resistant to certain herbicides [**5**]. Apparently this approach is based on assumption that herbicides would act independently when applied simultaneously or sequentially [**6**]. However, it has been demonstrated that herbicides may interact before and after entering the plant and the outcome of the interaction can be synergetic, antagonistic or additive depending on whether the combined effect on the plant is greater, less than or equal to the summed effect of the herbicides applied alone [**7**]. Therefore, it is necessary to evaluate the combination of different herbicides to get the synergetic effect one on the other.

Materials and Methods

Description of the Study Area

Wonji shoa sugar estate: is located at a distance 107 km to the east of Addis Ababa between $39^0$10`-$39^0$20`N to $8^0$30' to $8^0$35`Eat elevation of 1550masl. It receives an average of 820mm annual rainfall with minimum and maximum temperature of 15.3°C and 26.6°C.

Experimental Procedures

The experiment was conducted at Wonji-Shoa sugar estate 2017/2018 cropping seasons. For the trial, variety NCO-334 was used. The test herbicides included in this trial were POWER 860 SL (2, 4-D amine salt) and Master 480 SC (Metribuzin) (Table 1) and unweeded control plots were included in the trial to ease comparison. The test herbicides were applied as post-emergence application (herbicide applied when both the weed and the cane emerged and the weed reached 3-5 leaf stage). Master 480 SC was combined at two level of rate (1lt/ha and 1.5lt/ha) with three level rate (1lt/ha, 1.5lt/ha and 2lt/ha) of POWER 860 on a plot size of six furrows of 5 m length each (43.5 m^2). The experiment was carried out in RCBD design in factorial arrangement with three replications for one cropping season. The herbicides were applied on each plot using manual knapsack sprayer. All other cultural practices of the site were the same as recommended, except the weed control practice. Efficacy of the candidate herbicides were determined both qualitatively and quantitatively and phytotoxicity effect was determined qualitatively. For qualitative evaluation, visual rating of efficacy and phytotoxicity effect was made using the European system of weed control and crop injury evaluation scale (1-9) [**8**] (Table 2). For quantitative analysis, efficacy of the herbicides was determined

***Corresponding author:** Amrote Tekle, Ethiopian Sugar Industry, Group Sugar Research Center, P.O. Box 2003-1000, Wonji, Ethiopia, E-mail: amrotetekle@gmail.com

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Table 1: Treatment Combination.

No	Herbicides trade name	Common name
1	Master 480 SC alone at1.5lt/ha (CHECK)	Metribuzin
2	Master 480 SC at1lt/ha + POWER 860SL at1lt/ha	Metribuzin +2-4D amine salt
3	Master 480 SC at1lt/ha + POWER 860SL at1.5lt/ha	Metribuzin +2-4D amine salt
4	Master 480 SC at1lt/ha + POWER 860SL at2lt/ha	Metribuzin +2-4D amine salt
5	Master 480 SC at1.5lt/ha + POWER 860SL at1lt/ha	Metribuzin +2-4D amine salt
6	Master 480 SC at1.5lt/ha + POWER 860SL at1.5lt/ha	Metribuzin +2-4D amine salt
7	Master 480 SC at1.5lt/ha + POWER 860SL at2lt/ha	Metribuzin +2-4D amine salt
8	Hand Weeded control	-
9	Unweeded control	-

Table 2: European System for weed control and crop injury Evaluation Scale.

Rating scale	Effect on weeds	Effect on crop
1	Complete kill	No effect
2	Very good	Very light symptoms
3	Good	Light symptoms
4	Sufficient in practice	Symptoms not reflected in yield
5	Medium	Medium
6	Fair	Fairly heavy damage
7	Poor	Heavy damage
8	Very poor	Very heavy damage
9	No effect	Complete kill

by percent weed control in the treated plot in comparison with that of untreated plot as used in [**9**].

Data Collection and Analysis

Weed count was accomplished by using 0.25m^2 quadrants taken randomly at 10 days interval for two month after spray. Five quadrant samples were taken per plot; the number of individual plants of each species was counted, and observations were made before and after application. (i.e before spray counting was done one day before spray). Sprout and Tiller count were done at 45 days and four month after planting. Data on percent weed control, sprout and tiller population were subjected to SAS statistical software package 9.0 version.

Result and Discussions

Quantitative Evaluation the Efficacy of the Test Herbicides on Weeds Control

Analysis of variance of efficacy of the test herbicides on the basis of their percent weed control potential on broad leaved indicated that, there were non-significant differences ($p \leq 0.05$) among the test herbicides mixture including Master 480 SC alone which control the weed effectively by far of the acceptable rage percent weed control ≥ 70%. In line with the above result, literatures indicated that efficacy of the herbicides ≥ 70 % is regarded as satisfactory **[8].**

Of the test herbicides Master 480 SC alone at its recommended rate 1.5lt/ha and the combination of Master 480 SC at 1lt/ha + POWER 860SL at 1 and 2lt/ha revealed the best percent weed control potential for both broad and grass weed species non-significantly. On the other hand, the combination of Master 480 SC at 1.5lt/ha + POWER 860SL at 1.5lt/ha and 2lt/ha have also gave an acceptable range of percent weed control which is ≥ 70% for grass and broad leaved weed species. However, All the test herbicides except Master 480 SC at 1.5lt/ha + POWER 860SL at1.5lt/ha, control sedge below their acceptable range of percent weed control i.e. ≤ 70%.

Although, Master 480 SC alone at 1.5lt/ha showed greater percent grass weed control figuratively, its current price (1575 Birr/ha) is not comparable with the combination of Master 480 SC at 1lt/ha + POWER 860SL @1lt/ha i.e. 1220 Birr/ha. This implies that, using the combination of Master 480 SC and POWER 860SL by reducing 34% and 67% of their recommended rate at 1.51lt/ha and at 3lt/ha respectively have cost advantage of 355 birr/ha over Master 480 SC alone at 1.5lt/ha. Moreover, Master 480 SC at 1.5lt/ha + POWER 860SL at 1.5lt/ha still has 20 Birr/ha cost advantage as compared to Master 480 SC at 1.5lt/ha alone. Besides, using the lower rate of these herbicides might have also positive contribution on environmental contamination. According to [**11**], the grower would require several subsequent applications in order to fully control all weeds since the weeds are variable and require specific herbicides. This increases operating costs in terms of labour and is time wasting. Alternatively, herbicides can be combined in a tank mix which is applied in a single once off to control a wider weed spectrum.

In addition the combination of Master 480 SC at 1.5lt/ha + POWER 860SL at 1.5lt/ha showed a synergistic effect in controlling of sedge which is unable to control by Master 480 SC alone at 1.5lt/ha. Therefore, this is a great advantage obtained by mixing Master 480 SC with POWER 860SL rather using Master 480 SC alone. Similarly Green, 1991 reported that a single once-off application of herbicide mixture ensures that the grower to controls different weed species simultaneously with a single application increasing efficiency [**12-14**].

In similar study the herbicide tank mix of pendimethalin (2l/ha) + atrazine (2l/ha) significantly controlled all weed species except Ipomoea sinensis which was effectively reduced by metribuzin and Extreme plus (0.8l/ha). two were tank mixed they performed better than when chlorimuron was used singly. When Metribuzin is tank mixed with Chlorimuron, Chlorimuron adopts an aphosphatic and copper group bearing a positive charge. This improves its absorption rate by the crop and also its efficacy in disrupting the metabolism of the seed and seedling [**10**].

Qualitative Evaluation the Effect of the Test Herbicides on the Weed and Sugarcane Crop

The result of qualitative evaluation (visual observation) of efficacy of the herbicides were under the test on weed control potential was fall between very good, good and medium to poor on sugarcane complex weed (Broad, Grass and sedge) respectively (Table 4). The quantitative result (percent weed control) of the test herbicides stated on (Table 3) was also in line with the above finding. Therefore, the candidate herbicides were found promising result on weed control efficiency both quantitatively and qualitatively. On the other hand, the effects of the test herbicides on the crop (phytotoxicity) based on European system of weed control and crop injury evaluation scale showed that Very light symptom and medium to light symptom. Therefore, there was no severe crop injury due to the test herbicides. Hence, all the tested herbicides were found to be safe to sugarcane crop [**15**].

Effects of the Test Herbicides on the Performance of Sprout Percent and Tiller Population

The analysis result of the test herbicides on sprout percentage showed that, plots received Master 480 SC alone at 1.5lt/ha revealed the highest percent sprout followed by plots received the combined treatments Master 480 SC at 1.5lt/ha + POWER 860SL at 2lt/ha and Master 480 SC at 1lt/ha + POWER 860SL at 1lt/ha.

However, there was no statistically significant differences were observed among these treatments. On the other hand, the unweeded check plot were showed obviously the list percent sprout comparing to the treated plots.

Regardless of tiller population count for the test herbicides, indicated that there was statistically non-significant difference among treatments except plot received the combination of Master 480 SC at 1lt/ha + POWER 860SL at 2lt/ha which resulted relatively the lowest tiller population i.e. 350.6 (**'000/ha)** as compared to the remaining treated plots. This is attributed to plots recorded the better percent weed control can also revealed the better agronomic performance (Table 5). In line with the above finding, reports indicated that a better yield or tiller number resulted from herbicidal control measure could only be ensured if it had a better control potential against weeds (Howard et al., 2001). Hence, the better tiller number recorded due to the exploitation of the test herbicides resulted from the better weed control potential exhibited than that of the remaining treatments. In similar manner of percent sprout, the list (224.33 (**'000/ha)** tiller population was also recorded on the unweeded check plot. Therefore, using appropriate herbicidal weed control in supplement with other weed control options were mandatory to manage weeds and reduce expected yield losses efficiently.

Table 3: Efficacy of the test herbicides on percent weed control.

Treatment Description	Percent Weed Control		
	Broad	Grass	Sedge
Master 480 SC alone at 1.5lt/ha (CHECK)	94.1a	94.2a	66.7ab
Master 480 SC at 1lt/ha + POWER 860SL at 1lt/ha	97.5a	88.2a	62.1ab
Master 480 SC at 1lt/ha + POWER 860SL at 1.5lt/ha	86.4a	66.8b	49.2abc
Master 480 SC at 1lt/ha + POWER 860SL at 2lt/ha	87.2a	86.3a	55.6abc
Master 480 SC at 1.5lt/ha + POWER 860SL at 1lt/ha	97.2a	69.3b	33.3abcd
Master 480 SC at 1.5lt/ha + POWER 860SL at 1.5lt/ha	90.1a	79.2ab	92.5a
Master 480 SC at 1.5lt/ha + POWER 860SL at 2lt/ha	94.5a	71.9ab	55.6abc
Hand Weeded control (check)	84.5a	83.8a	73.6ab
Unweeded control (check)	58.3b	49.7c	18.3d
CV (%)	11.72	25.9	32.0
Lsd	17.6	33.8	53.5

Conclusion and Recommendation

Herbicides mixtures were under the test, control broad leaved weeds in acceptable rages of percent weed control which is ≥ 70%. Tank mixing of Master 480 SC and POWER 860 SL by reducing 34% and 67% of their recommended rate 1.51lt/ha and 3lt/ha respectively were control broad and grass weeds effectively in comparable with the standard check Master 480 SC alone implying using these combination also have cost advantage of 355 birr/ha over the treated check. Applying

Table 4: Phytotoxicity Effect of the Test Herbicides on Weeds and Crop.

The test Herbicides	Effect on weeds			Effect on crop
	Broad	Grasses	Sedges	
Master 480 SC alone at 1.5lt/ha (CHECK)	2	2	6	Light symptom
Master 480 SC at 1lt/ha +POWER860SL at 1lt/ha	2	2	6	Light symptom
Master 480 SC at 1lt/ha +POWER860SL at 1.5lt/ha	2	6	7	Medium
Master 480 SC at 1lt/ha +POWER860SL at 2lt/ha	2	2	7	Symptom not reflected on yield
Master 480 SC at 1.5lt/ha +POWER860SL at 1lt/ha	2	5	7	Medium
Master 480 SC at 1.5lt/ha +POWER860SL at 1.5lt/ha	2	3	2	Very light symptom
Master 480 SC at1.5lt/ha +POWER860SL at 2lt/ha	2	4	2	Light symptom

Table 5: Effect of the test herbicides on sprout and tiller count.

No	Treatment Description	Sprout (%)	Tiller count ('000/ha)
1	Master 480 SC alone at 1.5lt/ha (CHECK)	92.71a	416.67a
2	Master 480 SC at 1lt/ha + POWER 860SL at 1lt/ha	86.58ab	474.00a
3	Master 480 SC at 1lt/ha + POWER 860SL at 1.5lt/ha	73.73ab	433.33a
4	Master 480 SC at 1lt/ha + POWER 860SL at 2lt/ha	69.03ab	350.6ab
5	Master 480 SC at 1.5lt/ha + POWER 860SL at 1lt/ha	77.78ab	478.00a
6	Master 480 SC at 1.5lt/ha + POWER 860SL at 1.5lt/ha	73.38ab	453.67a
7	Master 480 SC at 1.5lt/ha + POWER 860SL at 2lt/ha	87.39a	410.00a
8	Hand Weeded control (check)	88.89a	486.00a
9	Unweeded control (check)	54.63b	224.33b
CV (%)		**24.13**	**25.84**
Lsd		**32.4**	**183.51**

mixtures of Master 480 SC at 1.5lt/ha and POWER 860SL at 1.5lt/ha is a better control measure and synergy effect against sedge.

The candidate herbicides were found promising result on weed control efficiency both quantitatively and qualitatively. There was no severe crop injury due to the test herbicides reflected on yield; which are all the tested herbicides were found to be safe to sugarcane crop.

A better percent sprout and tiller population were found on plots received a better herbicidal weed control potential.

Therefore based on the above findings the following recommendation were made

The plantation can use the tank mixtures of Master 480 SC at 1lt/ha with POWER 860SL at 1lt/ha for the control of grass and broad weeds.

The plantation can also use tank mixtures of Master 480 SC at1.5lt/ha + POWER 860SL at 1.5lt/ha for the control of grass and broad weeds as well as on a sugarcane field dominantly affected by sedge weed species.

Master 480 SC 1lt/ha + POWER 860SL 1lt/ha

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