Study of Different Rates of Application of Mixture of Amidosulfuron and Iodosulfuron-Methyl-Sodium on Broadleaf Weed Infestation and Grain Yield of Soft Wheat

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

| Short Research Article |

ABSTRACT

Aims: A soft wheat weed control trial was conducted in order to investigate the effect of mixture of Amidosulfuron and Iodosulfuron-methyl-sodium on controlling broadleaf weeds infestation in a soft wheat crop.
Study Design: The experimental design was a random block with three replications. Each block contained 4 elementary plots, 3 plots of which are treated with three doses of mixture of Amidosulfuron and Iodosulfuron-Methyl-Sodium and one untreated control plot.
Place and Duration of Study: Field experiments in Ouazzane region of Morocco. Laboratory measurements were carried out at weed research laboratory of INRA-CRRA Tangier. Morocco, between December 2016 and July 2017.
Methodology: Treatments was applied at weed seedling stage. Three doses of mixture of Amidosulfuron and Iodosulfuron-methyl-sodium were applied. Observations were made 14, 28 and 56 days after application of herbicides (DAT). Observations concerned selectivity of applied treatments, percentage of weed density reduction, biomass reduction and soft wheat grain yield.

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Results: Results showed that treatments with mixture of 15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium and 22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium gave the best control of broadleaf weeds infestations and provided the best wheat grain yield. No phytotoxic symptoms were observed on soft wheat crop. Treatment with mixture of (15g/ha Amidosulfuron+ 3.75 g/ha Iodosulfuron-methyl-sodium) recorded 95.7±1.3%, and 98.5±0.5% respectively on weed density reduction, and weed dry biomass reduction. Treatment with mixture of (22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium) recorded 98.5±0.5% and 98.8±0.3% respectively on weed density reduction and weed dry biomass reduction. Treatment with mixture of (7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium) recorded the lowest efficacies 60.7±10.2% and 70.2±3.3% respectively on weed density reduction and weed dry biomass reduction. Plots treated with mixture of (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) and (22.5 g/ha Amidosulfuron+ 5.63 g/ha Iodosulfuron-methyl-sodium) recorded the highest yields of 3.65±0.1 and 3.46±0.3 tons/ha respectively an increase exceeding 74% over the control.

Conclusion: Mixture of (15 g/ha Amidosulfuron+ 3.75 g/ha Iodosulfuron-methyl-sodium) and (22.5 g/ha Amidosulfuron+ 5.63 g/ha Iodosulfuron-methyl-sodium) gave the best control of weed infestation in soft wheat and recorded the best grain yield. Therefore, mixture of (15 g/ha Amidosulfuron+ 3.75 g/ha Iodosulfuron-methyl-sodium) can be recommended in similar weed infestation in soft weed crop.

1. INTRODUCTION

In Morocco, cereal crops play a very important role in agriculture and has long been the main plant production system and the basis of the diet of the majority of the population. In fact, about 5 million hectares are covered annually by cereals, more than 59% of the national useful agricultural area [1]. Soft wheat covers an area of 2 million hectares and it is ranked first in terms of cereal production [1]. However, the national average yield per hectare remains low. Low yield is a consequence of various environmental constraints, including the high irregularity of rainfull and its distributions. In addition, soft wheat is affected by a large number of pests including diseases, insects and weeds [2]. In fact, the presence of weeds in a wheat field can cause yield losses of up to 70% depending on the region, the climatic conditions and the nature of weed flora [3]. These losses are the result of competition for water, minerals and light that directly affects the growth of the crop and its subsequent yield [4,5,6,7,8,9,10]. Massive infestations also hamper tillage and harvesting operation and make the success of these operations problematic. Chemical weed control remains the most suitable method for controlling weeds [9]. Mixture of Amidosulfuron + Iodosulfuron-Methyl-Sodium is a post-emergence herbicide used for controlling broadleaf weeds in cereals [11]. It is oil dispersion formulation (OD) with Mefenpyr-diethyl as safener. It belong to sulfonylurea family that causes inhibition of acetolactate synthase ALS (acetohydroxyacid synthase AHAS). The active ingredients are taken up by roots and leaves and translocated in weed plants causing growth arrest [11]. Weed infestation in cereals differ from regions. Weed sensitivity to herbicides closely depends on the existing flora and the applied herbicide dose. Thus, the aim of this study is to compare the effect of different rates of application of Mixture of Amidosulfuron + Iodosulfuron-Methyl-Sodium on weed infestation and soft wheat grain yields to determine the best rate of application.

2. MATERIALS AND METHODS

A weed control trial was conducted during the 2016-2017 growing season in Ouazzane region, Morocco. The plant material used is a soft wheat, sown before tracing the experimental design in order to choose the most homogeneous plots. The experimental design was Randomized Complete Block Design (RCBD) with three replications. The distance between the blocks is 2m and the distance between the plots is 1m. Each block contains 4 elementary plots of which 3 plots are treated with the herbicides tested and 1 plot is maintained without any weeding as controls. The size of the elementary plots is 3x5 meters (15 m^2). Treatments were applied at weed seedling stage (Table 1). Treatments were carried out using a Backpack herbicide sprayer with nozzle delivering a 3 bar jet. The spray volume per hectare is 200L. Observations were

made 14, 28 and 56 days after application of herbicides (DAT). Observations concerned selectivity of applied treatments, percentage of weed density reduction, biomass reduction and soft wheat grain yield. Phytotoxicity observations on leaf injury were scored according to a scale ranging from 0 to 100% (0%: no symptoms of phytotoxicity and 100%: generalized phytotoxicity symptoms of leaf injury on tips/surface, wilting, necrosis). Weed density reduction percentage was calculated using the equation= [Weed density in control plots – Weed density in treated plots] x 100 / [Weed density in control plots], Calculation of the density at the experimental level of the plot was made by a quadrant of 50 cm x 50 cm. Weed dry biomass reduction percentage was calculated using the equation= [Weed dry biomass weight in control plots – Weed dry biomass weight in treated plots] x 100 / [Weed dry biomass weight in control plots]. Calculation of dry Weed biomass were made by collecting Weed in each plot using a quadrant of 50 cm x 50 cm. Samples were dried in a drying oven at 75°C for 48 hours at weed research laboratory of INRA-CRRA Tangier. Then, dry plant material in each plot were weighed with a precision balance. At maturity, grain yield were recorded using a quadrant of 1m x 1 m, samples were taken from the center of each plot. Statistical analyzes were performed with IBM SPSS software version 21.0 using the analysis of variance (ANOVA) [12]. The differences among treatment means was compared by Tukey's test at p = .05. Correlation coefficient of Pearson was calculated to determine association of grain yield and observed efficacies.

3. RESULTS AND DISCUSSION

3.1 Weed Flora Infestation

Dominant weed botanical families in the experimental site are: Asteraceae (44%), Brassicaceae (22%), Rubiaceae (11%), Amaranthaceae (11%) and Malvaceae (11%). Dominant weed species are: *Chrysanthemum coronarium* L., *Chrysanthemum segetum* L., *Gallium tricornutum* Dandy, *Chenopodium album* L., *Sonchus oleraceus* L., *Diplotaxis catholica* (L.) DC., *Sinapis arvensis* L., *Malva parviflora* L., *Centaurea diluta* Aiton (Table 2).

3.2 Soft Wheat Selectivity

It was observed from the weed control trial that no treatment had any phytotoxic effect on crop plants at any stage of the soft wheat crop. Therefore, treatment with Amidosulfuron + Iodosulfuron-methyl-sodium with tested rates of application has no any phytotoxicity on soft wheat.

Table 1. Applied herbicides and rates

Herbicide treatments	Rate of application and active ingredient
Treatment 1	7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium
Treatment 2	15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium
Treatment 3	22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium

Table 2. Dominant weed flora in experimental site

Scientific Names	Botanical families	Life cycle
Centaurea diluta Aiton	*Asteraceae*	Annual
Chenopodium album L.	*Amaranthaceae*	Annual
Chrysanthemum coronarium L.	*Asteraceae*	Annual
Chrysanthemum segetum L.	*Asteraceae*	Annual
Diplotaxis catholica (L.) DC.	*Brassicaceae*	Annual
Gallium tricornutum Dandy	*Rubiaceae*	Annual
Malva parviflora L.	*Malvaceae*	Annual
Sinapis arvensis L.	*Brassicaceae*	Annual
Sonchus oleraceus L.	*Asteraceae*	Annual

3.3 Effect on Reduction of Density in Broadleaf Weeds

Statistical analysis did not reveal a difference in effect between different treatments on the density of dicotyledonous weeds during the first evaluation periods (14 DAT). While a significant difference at 28 DAT is shown with significant (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) and (22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium) efficacies recording 79.8±5% and 83.3±3.4% respectively. (7.5 g/ha Amidosulfuron+ 1.88 g/ha Iodosulfuron-methyl-sodium) was the least effective (21±3.1%). At 56 DAT, all treatments showed excellent effect against dicotyledonous weeds ranging from 95.7±1.3% (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) to 98.5±0.5% (22.5 g/ha Amidosulfuron + 5.63g/ha Iodosulfuron-methyl-sodium) except (7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium) which was able to reduce the density of dicotyledonous weeds by 60.7±10.2% (Table 3). The effect of herbicides on weed density cannot be used solely to assess their efficacies. Hence, the interest to include effect on weed biomass.

3.4 Effect on Reduction of Biomass in Broadleaf Weeds

Statistical analysis did not reveal a difference in effect between the different treatments (effect on biomass) on dicotyledonous weeds, during the first evaluation periods (14 DAT). Efficacy ranged from 23.8±8.1% (7.5g/ha Amidosulfuron+ 1.88 g/ha Iodosulfuron-methyl-sodium) to 32.2±5.1% (22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium) at 14 DAT. The efficacies of treatments were weak to very good at 28 DAT ranging from 54.2±4.3% (7.5g/ha Amidosulfuron+ 1.88 g/ha Iodosulfuron-methyl-sodium) to 98.3±0.8 (22.5 g/ha Amidosulfuron +

5.63 g/ha Iodosulfuron-methyl-sodium). At 56 DAT, all treatments showed excellent effect against biomass of dicotyledonous weeds ranging from 98.5±0.5% (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) to 98.8±0.3% (22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium) except (7.5 g/ha Amidosulfuron+ 1.88 g/ha Iodosulfuron-methyl-sodium) which was able to reduce the biomass of dicotyledonous weeds by 70.2±3.3% (Table 4). The combination of two active ingredients Amidosulfuron and Iodosulfuron-methyl-sodium ensures the control of dicotyledonous weed in wheat crop [11]. The herbicide is selective and well tolerated by wheat processed with safener. Herbicide formulation is an important factor of its active ingredients activity. All treatments applied in the test plot have not shown significant efficacy in the first periods (14 DAT), this may be due to the mode of action of herbicide used that act as inhibitors of amino acids that act by slowing down plant growth, but whose visible effects are long to manifest [13].

3.5 Effect on Soft Wheat Grain Yield

Grain yield differ significantly between different treatments. Compared to control, all treatments have resulted in higher yields. Control grain yield does not exceed 1.98±0.07 tons/ha. In fact, control grain yield explains the depressive effect of weeds that resulted in grain yield losses of 1.67 tons/ha, a decrease of 45.8% from the maximum yield. The reduced application rate (7.5g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium) recorded 2.62±0.21 tons/ha. Among the treatments that achieved high yields were (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) and (22.5g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium) which recorded 3.65±0.1 and 3.46±0.3 tons/ha respectively, an increase exceeding 74% over the control (Table 5). However, statistical

Table 3. Effect of herbicide treatments on reduction of density in broadleaf weeds (%)

Evaluation Period	Treatments			Pα = .05
	T1	T2	T3	
14 DAT	5.5±4.1	9.2±4.2	14,7±6.9	.179
28 DAT	21±3.1 [b]	79.8±5 [a]	83.3±3.4 [a]	< .001
56 DAT	60.7±10.2 [b]	95.7±1.3 [a]	98.5±0.5 [a]	< .001

Data represented are mean ± standard deviation for (n=3).Significant differences within the same row and means followed by the same letter do not differ at p= 0.05 according to Tukey's test.
DAT: Days after Treatment.
T1: 7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium
T2: 15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium
T3: 22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium

Table 4. Effect of herbicide treatments on broadleaf weeds dry biomass reduction (%)

Evaluation Period	Treatments			Pα = .05
	T1	T2	T3	
14 DAT	23.8±8.1	27.7±5.7	32.2±5.1	.351
28 DAT	54.2±4.3 [b]	95.2±1.6 [a]	98.3±0.8 [a]	< .001
56 DAT	70.2±3.3 [b]	98.5±0.5 [a]	98.8±0.3 [a]	< .001

Data represented are mean ± standard deviation for (n=3).Significant differences within the same row and means followed by the same letter do not differ at p= 0.05 according to Tukey's test.
DAT: Days after Treatment.
T1: 7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium
T2: 15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium
T3: 22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium

Table 5. Effect on soft wheat grain yield

Treatments	Grain yield (tons/ha)
T1	2.62±0.21 [b]
T2	3.65±0.10 [a]
T3	3.46±0.30 [a]
Control	1.98±0.07 [c]
Pα = 0.05	< 0.001

Data represented are mean ± standard deviation for (n=3).Significant differences within the same column and means followed by the same letter do not differ at p= 0.05 according to Tukey's test
T1: 7.5 g/ha Amidosulfuron + 1.88 g/ha Iodosulfuron-methyl-sodium
T2: 15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium
T3: 22.5 g/ha Amidosulfuron + 5.63 g/ha Iodosulfuron-methyl-sodium
Control: Unweeded

Table 6. The correlation between soft wheat grain yield and recorded herbicide efficacies

Soft wheat grain yield	r	p value
Reduction of weed density at 14 DAT	0.656*	.021
Reduction of weed density at 28 DAT	0.949**	< .001
Reduction of weed density at 56 DAT	0.939**	< .001
Reduction of weed biomass at 14 DAT	0.824**	0.001
Reduction of weed biomass at 28 DAT	0.957**	< .001
Reduction of weed biomass at 56 DAT	0.919**	< .001

DAT: Days after Treatment
r: Pearson correlation
* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level

analysis did not reveal any significant differences between means of this two treatment. Therefore there is no need to increase the rate of application. Hence, treatment with (15 g/ha Amidosulfuron + 3.75 g/ha Iodosulfuron-methyl-sodium) is the best rate of application which allows best control of weed infestation and provides best yield. It is important to mention that the correlation coefficient between soft wheat grain yield and recorded herbicide efficacies showed that a significant relationship exist between grain and recorded herbicide efficacies (Table 6). This means that grain yields are higher as the treatment efficacies increase.

4. CONCLUSION

In this study, three rates of application of mixture of Amidosulfuron and Iodosulfuron-Methyl-Sodium were tested on controlling broadleaf weeds infestation in a soft wheat crop. Result show that grain yields are higher as the treatment efficacies increase. Reduced rate of application at (7.5 g/ha Amidosulfuron+ 1.88 g/ha Iodosulfuron-methyl-sodium) did not show significant effect on weed infestation and provided lower grain yield. Mixture of (15 g/ha Amidosulfuron+ 3.75 g/ha Iodosulfuron-methyl-sodium) and mixture of (22.5 g/ha Amidosulfuron+ 5.63 g/ha Iodosulfuron-methyl-

sodium) gave the best control of weed infestation in soft wheat and recorded the highest grain yield. Therefore, mixture of (15 g/ha Amidosulfuron+ 3.75 g/ha Iodosulfuron-methyl-sodium) can be recommended in similar weed infestation in soft weed crop.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by INRA Morocco.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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