http://dx.doi.org/10.22161/ijeab.4430 ISSN: 2456-1878

Evaluation of the effect of Rimsulfuron and Linuron on weed infestation and potato yield

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Abstract*— *A potato weeding trial was conducted during the 2017 growing season. The purpose of this experimentation is to evaluate the effect on weed infestation and impact on potato yield of tow herbicides: Linuron as preemergence herbicide and Rimsulfuron as postemergence herbicide. Results showed that the best potato yields are obtained by treatments that gave the best weed control. Linuron with a rate of 187.5 g/ha has shown excellent efficacy exceeding 93% of weed control and giving yields exceeding 46.3 tons / ha. Treated plots with Rimsulfuron at 15 g/ha gave in average 78% of weed control and may be recommended when the pre-emergence weed treatment is missed.

***Keywords*— Potato, Weed, efficacy, yield, Rimsulfuron, Linuron.**

I. INTRODUCTION

Potato (*Solanum tuberosum* L.) is a perennial plant native to South America and belongs to the *Solanaceae* family (Skiredj et *al*., 2002 ; Chafik & Taleb, 2012). It is one of the world's fourth most important food crop after rice, wheat and corn (More & *al*., 2016). Potato tubers are very nutritive because they are rich source of starch, vitamins and minerals. It was introduced in Morocco in the nineteenth century, currently it is cultivated intensively throughout the growing season (Fahad & *al*., 2012). Total annual potato production is estimated at 1.5 million tons, representing around 25% of national vegetable production and consumption (Guennouni, 2011). It covers an annual area of 60000 ha in Morocco (Guennouni, 2011). It is considered the first in terms of area and production (Fahad & *al*., 2012 ; Hafidi & *al*., 2012). Potato exports are mainly to the European Union (France, Holland and Spain) and Russia (Hormatallah & *al*., 2012). This crop is important because it contributes to job creation in rural areas and to the satisfaction of population food needs (Kharmach, 2012). The Larache area (Nothern Morocco) occupies the fourth place in Morocco in terms of potato production with an area of 6400 ha and a production of 156 000 tons with an average yield of 31.5 tons / ha (MAPMDREF, 2017). To increase potato yields in terms of quantity and quality requires the improvement of seed varieties, irrigation, fertilization, disease control, insect control and weed control (Chibane, 1999). In fact, weeds can reduce yields through competition for water and nutrients or hinder the harvesting process and become a host of insects and diseases. Broadleaf weeds largely dominate the adventitious flora of the potato with about 85% of total weed species (Chafik & Taleb, 2012 ; Tanji & *al*., 2012a). In the Larache region, the most abundant species in the potato fields are *Cyperus Rotundus, Digitaria sanguinalis, Setaria verticillata , Amaranthus deflexus, Protulaca oleracea* (Tanji et *al* ., 2012b). Hilling and hoeing are among the main techniques for controlling weeds, and the scarcity and high cost of labor makes these operations problematic and expensive. So to overcome this problem, chemical weeding is relatively less dependent on labor and saves time and money. The interval between planting and the emergence of the potato is relatively sufficient to allow the emergence of weeds (Stephens, 1962). Therefore, weed control at the beginning of the cycle is very important. However, some weeds may appear in the middle of the cycle and can affect potato yields, which may require the need for post-emergence herbicide application. In this context, comes the interest of this research work which aim to evaluate herbicide efficacy of pre-emergence (Linuron) and post-emergence (Rimsulfuron) herbicides and their impact on potato yields.

II. MATERIAL AND METHODS

A potato weeding trial was conducted at the Larache INRA Research Station Morocco during 2017 growing season. The average annual rainfall is about 700 mm concentrated for almost all between October 15th and April 15th. The soil texture is sandy. The crop was planted on March 17, 2017. Pre-emergence treatment were carried out at March 20, 2017. Post-emergence treatments were carried out on April 17, 2017. The experimental design is a random block with four repetitions. The size of the elementary plot is 3m x 8m. Each block consists of four elementary plots: three

http://dx.doi.org/10.22161/ijeab.4430 *ISSN: 2456-1878*

treatments in addition to a non-weed control. The treatments are carried out with Backpack herbicide sprayer with nozzle delivering a 3 bar jet. The spray volume per hectare is 200L. Observations of efficacy are made a month and a half after planting on a scale ranging from 0 to 100%. At the end of the cycle, the yield is evaluated with a quadrat of 3 m ^{2}. Statistical analyzes are performed with *SPSS* software *version 21*.

Table 1: Applied herbicides

Herbicide active ingredient	Dose per ha	Observation
Rimsulfuron	10 g / ha	Application at the 2 to 5 leaves stage of the crop
Rimsulfuron	15 g / ha	Application at the 2 to 5 leaves stage of the crop
Linuron	187,5 g / ha	Application in pre-emergence

III. RESULTS AND DISCUSSION

1. Weed flora Infestation

Weed flora in the experimental site was diverse, the dominant botanical families are: *Amarantaceae, Poaceae, Cyperaceae and Polygonaceae*. Dominant weed species were: *Amaranthus blitoides, Amaranthus deflexus, Amaranthus retroflexus* (Table 2).

Table 2: Weed flora in experimental site

Scientific Name	Common Name
Amaranthus blitoides S. Watson	MAT AMARANTH
Amaranthus deflexus L.	LARGE-FRUIT AMARANTH
Amaranthus retroflexus L.	RED-ROOT AMARANTH
Avena sterilis L.	WILD OAT
Bromus rigidus Roth	RIPGUT BROME
Cynodon dactylon (L.) Pers.	BERMUDA GRASS
Cyperus esculentus L.	YELLOW NUTSEDGE
Cyperus rotundus L.	NUT GRASS
Dactyloctenium aegyptium (L.) Willd.	EGYPTIAN CROWFOOT GRASS
Digitaria sanguinalis (L.) Scopoli	HAIRY CRABGRASS
Eleusine indica (L.) Gaertner	INDIAN GOOSEGRASS
Malva parviflora L.	CHEESEWEED
Misopates orontium (L.) Raf.	CORN SNAPDRAGON
Physalis pubescens L.	HAIRY NIGHTSHADE
Polygonum aviculare L.	COMMON KNOTGRASS
Portulaca oleracea L.	COMMON PURSLANE
Senecio vulgaris L.	GROUNDSEL
Solanum nigrum L.	BLACK NIGHTSHADE
Sonchus oleraceus L.	SOWTHISTLE

2. Herbicide efficacy on weeds

Statistical analysis revealed a very highly significant difference between treatments (table 3). Plots treated with Linuron showed the best efficacy by recording very good efficacy with 93% of weed control. In fact, the plots treated with Linuron was clean of weed throughout the growing cycle. Treatment with Rimsulfuron at 10 g / ha gave low efficacy (53%). As a result, this dose cannot be recommended for potato weed control. The dose of 15 g / ha of Rimsulfuron gave acceptable efficacy recording 78% of weed control. Thus, this dose may be recommended when pre-emergence weed control is missed or ineffective.

Table 3: Herbicide efficacy on weeds

Treatment	Efficiency (%) at 45 DAT *
Rimsulfuron (10 g / ha)	53 c
Rimsulfuron (15 g / ha)	78 b
Linuron	93 a
Pα = 0.05	< 0.00

** DAT: days after treatment*

3. Effect of treatments on potato yield

a. *Number of tubers / plant*

Statistical analysis revealed significant differences between treatments for their effect on the number of tubers per plant (table 4). Indeed, significant differences were revealed between Linuron and other treatments including the control. Linuron treated plots recorded 13.4 tubers per plant while the control recorded 8.1 tubers / plant. No significant difference was recorded between Rimsulfuron at 10g / ha, Rimsulfuron at 15g / ha and the control was recorded.

Table 4: *Effect of treatments on the number of tubers / plant*

Treatment	**Number of tubers / plant**
Rimsulfuron (10 g / ha)	10.1b
Rimsulfuron (15 g / ha)	9.1 b
Linuron	13.4 a
Control	8.1 b
Pα = 0.05	*< 0.00*

b. Average weight of tubers

Statistical analysis revealed highly significant differences between treatments in their effect on average tuber weight (table 5). Indeed, significant differences were revealed between Linuron and the other treatments including the control since the plots treated with Linuron recorded an average tuber weight of 129.6 g while Rimsulfuron at 10 g / ha, Rimsulfuron at 60 g / ha and control recorded weight means of tubers respectively 74.9 ; 95 and 75 g / tuber. In fact, it is important to mention that no significant difference was recorded between Titus at 40 g/ha and the control.

Table 5: Effect of the treatments on the average weight of the tuber (in g)

Treatment	**Average weight of the tuber (g)**
Rimsulfuron (10g /ha)	74.9 c
Rimsulfuron (15g /ha)	95.0 b
Linuron	129.6 a
Control	75.0 c
Pα = 0.05	*< 0.00*

c. Total yield (Tons / ha)

Statistical analysis revealed highly significant differences between the yields obtained by different treatments (table 6). The best yield was obtained by Linuron with an average yield of 46.3 tons / ha. No significant difference was recorded between Rimsulfuron at 10 g / ha, Rimsulfuron at 15g / ha and the control. In fact, plots treated with Rimsulfuron at 15 g / ha recorded 22.8 tons / ha and treated plots treated with Rimsulfuron 10 g / ha recorded 20.2 tons / ha while the control recorded the lowest yields with an average of 16.2 tons / ha.

Table 6: Effect of Treatments on Total Potato Yield (Tons / ha)

Treatment	**Total yield (Tons / ha)**
Titus 40 g	20.2 b
Titus 60 g	22.8b
Linuron	46.3 a
Control	16.2 b
Pα = 0.05	*< 0.00*

4. Correlation between treatment efficiency and yield components

Table 7: Correlation between Herbicide efficacy and potato yields

		Efficiency	**Yield (Tons / ha)**	**Average weight of the tuber**	**Number of tubers per plant**
Herbicide efficacy	Correlation of Pearson	1	0.779 *	0.912 **	0.532

http://dx.doi.org/10.22161/ijeab.4430 *ISSN: 2456-1878*

	Sig. (bilateral)		0.013	0.001	0.141
Yield (Tons / ha)	Correlation of Pearson	0.779 *	1	0.934 **	0.905 **
	Sig. (bilateral)	0.013		0.000	0.001
Average weight of the tuber	Correlation of Pearson	0.912 **	0.934 **	1	0.707 *
	Sig. (bilateral)	0.001	0.000		0.033
Number of tubers per plant	Correlation of Pearson	0.532	0.905 **	0.707 *	1
	Sig. (bilateral)	0.141	0.001	0.033	

**. The correlation is significant at the 0.05 level (bilateral). **. The correlation is significant at the 0.01 level (bilateral).*

The correlation coefficient shows a significant positive correlation between herbicide efficacy and total yield per hectare and a highly significant positive correlation between herbicide efficacy and average weight of tuber / plant weight. However, there is no significant correlation between the herbicide efficacy and the number of tubers per plant. In addition, positive and highly significant correlations were recorded between the total yields per hectare on the one hand and the average weight of the tuber and the number of tubers per plant on the other hand (table 7).

IV. CONCLUSION

This study has shown that the best potato yields are obtained by treatment giving the best efficacy. Plots treated with Linuron at 750 g / ha showed very good efficacy exceeding 93% of weed control and registered potato yields exceeding 46.3 tons / ha. Linuron application resulted in a yield difference of 30.1 tons / ha compared to potato yields recorded in control plots. This reveals the influence of weeds that severely affects potato yields and the importance of controlling weeds in pre-emergence. Treatment with Rimsulfuron at 15g / ha may be an alternative when the pre-emergence treatment is missed or ineffective.

V. ACKNOWLEDGMENT

The authors are grateful to all technicians of INRA Larache research station for providing necessary facilities for conducting this research work.

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