https://dx.doi.org/10.22161/ijeab.4455 ISSN: 2456-1878

Efficacy of Different Glyphosate rates of Application on Weed Infestation in Citrus Orchards

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Abstract*— *Citrus weeding trial was conducted during the 2019 growing season. The aimof this study is to investigate the effect of three glyphosate rates of application on weed infestation in citrus orchards. Dominant weed botanical families belong to: Asteraceae, Amaranthaceae, Caryophyllaceae,Solanaceae, Poaceae and Primulaceae.Results showed that glyphosate applied at 1080 g/hectareand 720 g/hectare provided good weed control. Glyphosate rates of application at 1080 g/hectare and 720 g/hectare recorded respectively 88.07% and 81% of weed density reduction compared to weed density in the control plots and 93.36% and 77.41% of weed dry biomass reduction compared to weed dry biomass in the control plots. Glyphosate rates of application at 1080 g/hectarerecorded 95% of visual weed control notation compared to weed infestation in the control plots.Glyphosate applied at 360 g/hectare showed very low efficacy and is not recommended in chemical weed control program in citrus orchards.

Keywords*— *Weed infestation, citrus, glyphosate, efficacy, density, biomass, Larache, Morocco.

I. INTRODUCTION

Citrus is one of the important fruit trees grown in Morocco (Walali&*al*., 2003). This crop plays a socio-economic role with an area of 125,000 hectares and a production average of 2 million tons per year (ASPAM, 2019). It contributes substantially to the improvement of the income of farmers and generates significant effects on job creation. Exports of citrus, represent an important source of foreign currency. Several biotic constraints limit their productivity including pests, diseases (viral and Cryptogamic), nematodes and weeds (Mokrini&*al*., 2018). In fact, weeds compete for growth factors such water, nutrients and light and reduce crop yield and quality (Onyegbule &*al*., 2014; Tucker & Singh 1993). The most common weeds in Moroccan citrus orchards belong to the following botanical families: *Poaceae, Asteraceae, Fabaceae, Brassicaceae* and *Boraginaceae* (Wahbi & Taleb, 1995; Hilali, 1995; Taleb &*al*., 1996; Bensellam &*al*., 1997; Talibi, 1999). There are various weed management practices that can reduce weed infestation in citrus orchards such cultivating, Mowing, Chemical weed Control, Biological Control and use of allelopathic plants (Tucker & Singh 1993). However, weed management with chemical control through herbicides is a cheaper and most effective practice against weed infestation especially when combined with other control measures (Bensellam & Bouhache, 2007). Glyphosate is a nonselective herbicide that kills mono and dicotyledonous plants of annual or perennial cycles. Glyphosate block the biosynthesis of aromatic amino acids produced through the shikimate pathway phenylalanine, tyrosine and tryptophan (Gravena and *al*., 2012; Index phytosanitaire Maroc, 2017). This herbicide is largely used worldwide due to its large spectrum efficacy against weed and cheaper cost. However, good chemical weed control by applying glyphosate is dependent on the nature of the dominant weed flora and the rates of application (Bensellam & Bouhache, 2007). Therefore,this study aims to evaluate theefficacy of three glyphosate rates of application to determine the rate of application that allows thebestweed control in citrus orchards in Larache Morocco region.

II. MATERIAL AND METHODS

A weeding trial was conducted at the Larache INRA Research Station Morocco during 2019 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 experimental design is a random block with tree repetitions. The size of the elementary plot is 5m x 5m. The age of citrus plantation is three years. Each block consists of four elementary plots: three treatments in addition to a non-weed control. The treatments are carried out on March 15, 2019 with

https://dx.doi.org/10.22161/ijeab.4455 *ISSN: 2456-1878*

Backpack herbicide sprayer with nozzle delivering a 3 bar jet. The spray volume per hectare is 200L. Treatments consist on three glyphosate rates of application (Table 1). Observations were made on May 08, 2019. Observations concerned Visual rating of efficacy on a scale ranging from 0 to 100% (where 0% is ineffective while 100% is a total destruction of weeds), Percentage of weed density reduction: *Weed density reduction percentage= [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 quardatof 1m x 1m. Percentage of dry biomass reduction: *Weed dry biomass reduction percentage= [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 weeds in each plot using a quardatof 1m x 1m. Samples were dried in a drying oven at 75 ° C for 48 hours. Then, dry plant material in each plot were weighed with a precision balance. Statistical analyzes are performed with SPSS software version 21.

Table 1: Applied herbicides in experimental site

Herbicide treatments	Glyphosate rates of application (g/hectare)
Treatment 1	360 g/hectare
Treatment 2	720 g/hectare
Treatment 3	1080 g/hectare

III. RESULTS AND DISCUSSION

1. Weed flora Infestation

Dominant weed botanical families in the experimental are: *Asteraceae* (33.3%),*Amaranthaceae* (22.2%),*Caryophyllaceae* (11.1%), *Solanaceae* (11.1%), *Poaceae* (11.1%), and*Primulaceae* (11.1%). Dominant weed species are: *Erigeron Canadensis*, *Chamaemelummixtum*, *Sonchusoleraceus*, *Chenopodiumopulifolium and Beta macrocarpa Cerastiumglomeratum* (Table 2).

Table 2: Weed flora in experimental site

Scientific Name	Common Name
Erigeron canadensis L.	CANADIAN HORSEWEED
Sloanum nigrum L.	EUROPEAN BLACK NIGHTSHADE
Anagallis arvensis L.	SCARLET PIMPERNEL
Beta macrocarpa Guss	BEET
Bromus rigidus Rhoth	RIPGUT BROME
Cerastium glomeratum Thuill.	STICKY MOUSE-EAR CHICKWEED
Chenopodium opulifolium Schrad.	SEAPORT GOOSEFOOT
Sonchus oleraceus L.	SOWTHISTLE
Chamaemelum mixtum (L.) All.	CHAMAEMELUM MIXTUM

1. Effect on visual efficacy rating

Statistical analysis revealed a very highly significant difference between treatments (table 3). Plots treated with 1080 g/hectare of glyphosate showed the best efficacy recording 95% of visual weed control notation compared to weed infestation in the control plots. Glyphosate Rate of application at 720 g/hectare showed also pretty good efficacy recording 83.67%. Glyphosate applied at 360 g/hectare showed moderate efficacy recording 63.33%.

Table 3: Effect on visual efficacy rating

Glyphosate rates of application	Visual efficacy rating(%)
1080 g/hectare	95 a
720 g/hectare	83.67 b
360 g/hectare	63.33 c
Pα = 0.05	*< 0.000*

Significant differences within the same column and means followed by the same letter do not differ at Pα≤0.05 according to Tukey's test.

2. Effecton weed density reduction

Statistical analysis revealed a very highly significant difference between treatments (table 4). Plots treated with 1080 g/hectare and 720 g/hectare of glyphosate showed the best efficacy recording respectively 88.07% and 81% of weed density reduction compared to weed density in the control plots. Glyphosate Rate of application at 360 g/hectare showed low weed density reduction recording 56.79%.

Table 4: Effect on weed density reduction

Glyphosate rates of application	Weed density reduction (%)
1080 g/hectare	88.07 a
720 g/hectare	81ab
360 g/hectare	56.79 b
Pα = 0.05	*0.001*

Significant differences within the same column and means followed by the same letter do not differ at Pα≤0.05 according to Tukey's test.

3. Effecton weed dry biomass reduction

Statistical analysis revealed a very highly significant difference between treatments (table 5). Plots treated with 1080 g/hectare and 720 g/hectare of glyphosate showed the best efficacy recording respectively 93.36% and 77.41% of weed dry biomass reduction compared to weed dry biomass in the control plots. Glyphosate Rate of

https://dx.doi.org/10.22161/ijeab.4455 *ISSN: 2456-1878*

application at 360 g/hectare sowed very low weed dry biomass reduction recording only32.44%.

Table 5: Effect on weed dry biomass reduction

Glyphosate rates of application	Weed dry biomass reduction (%)
1080 g/hectare	93.36 a
720 g/hectare	77.41 a
360 g/hectare	32.44 b
Pα = 0.05	*0.001*

Significant differences within the same column and means followed by the same letter do not differ at Pα≤0.05 according to Tukey's test.

In fact, some authors reported that glyphosate applied at 2160 g/hectare on citrus orchards in Gharb region in Morocco showed just 64.89% on weed dry biomass reduction compared to weed dry biomass in the control plots (Bensellam &Bouhache 2007). In our trial, half of this glyphosate rate of application has shown very good weed dry biomass reduction (93.36%). This can be explained by the nature of the weed species since weed infestation in Larache region is different fromthat of Gharb region. Therefore, it is important to test rates of application in different region before any recommendation to avoid low weed control (underdose) or the waste of herbicides (overdose).

IV. CONCLUSION

This study has shown that glyphosate rates of application at 1080 g/hectare and 720 g/hectare showed good weed control in citrus orchards in terms of dry biomass reduction, weed density reduction and visual weed efficacy notation. Glyphosate applied at 360 g/hectare is not recommended in chemical weed control program in citrus orchards in Larache region of Morocco.

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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