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

Hajjaj B, El Oualkadi A

National Institute of Agronomic Research, Tangier, Morocco
Corresponding author: h_badr15@yahoo.fr

Abstract—Citrus weeding trial was conducted during the 2019 growing season. The aim of 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/hectare and 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/hectare recorded 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 et 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 et al., 2018). In fact, weeds compete for growth factors such water, nutrients and light and reduce crop yield and quality (Onyegbule et 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 et al., 1996; Bensellam et 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 phyto sanitaire 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 the efficacy of three glyphosate rates of application to determine the rate of application that allows the best weed 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 5 m x 5 m. 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
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 = \[\frac{\text{weed density in control plots} - \text{weed density in treated plots}}{\text{weed density in control plots}} \times 100\%\]. Calculation of the density at the experimental level of the plot was made by a quadrat of 1m x 1m. Percentage of dry biomass reduction: Weed dry biomass reduction percentage = \[\frac{\text{weed dry biomass weight in control plots} - \text{weed dry biomass weight in treated plots}}{\text{weed dry biomass weight in control plots}} \times 100\%\]. Calculation of dry weed biomass were made by collecting weeds in each plot using a quadrat of 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 site 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, Chamaemelum mixtum, Sonchus oleraceus, Chenopodium opalifolium and Beta macrocarpa. 

### Table 2: Weed flora in experimental site

| Scientific Name | Common Name                  |
|-----------------|------------------------------|
| Erigeron canadensis L. | CANADIAN HORSEWEED            |
| Sloanum nigricum L. | EUROPEAN BLACK                |
| Anagallis arvensis L. | NIGHTSHADE                    |
| Beta macrocarpa Gass | BEET                          |
| Bromus rigidus Rhoth. | RIPGUT BROME                  |
| Cerastium glomeratum Thuill. | STICKY MOUSE-EAR          |
| Chenopodium opalifolium Schrad. | CHICKWEED                    |

### 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%.

| Glyphosate rates of application | Visual efficacy rating(%) |
|--------------------------------|----------------------------|
| 1080 g/hectare                 | 95 a                       |
| 720 g/hectare                  | 83.67 b                    |
| 360 g/hectare                  | 63.33 c                    |

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

### 2. Effect on 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%.

| Glyphosate rates of application | Weed density reduction (%) |
|--------------------------------|-----------------------------|
| 1080 g/hectare                 | 88.07 a                     |
| 720 g/hectare                  | 81ab                       |
| 360 g/hectare                  | 56.79 b                     |

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

### 3. Effect on 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
application at 360 g/hectare showed very low weed dry biomass reduction recording only 32.44%.

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                        |

\[ Pa = 0.05 \] 0.001

Significant differences within the same column and means followed by the same letter do not differ at Pa\( \leq 0.05 \) 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 from that 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.

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REFERENCES

[1] Gravena R., Filho R. V., Alves P. C., Mazzafera P., Gravena A. R. (2012). Glyphosate has low toxicity to citrus plants growing in the field. Canadian Journal of Plant Science (2012) 92. Pages: 119-127.
[2] ASPAM (2019). Association des producteurs d’agrumes du Maroc: http://maroc-citrus.com/statistiques-2/
[3] Bensellam E.H., Bouhache M., and Taleb A. (1997). Etude des adventices des vergers d’agrumes dans le Gharb : aspect floristique, écologique et agronomique. Weed Rese. 37. Pages: 201-210.
[4] Bensellam E.H., Bouhache M (2007). Effet de différentes méthodes de désherbage sur les adventices d’un verger d’agrumes. Revue Al Awamia 121. Page: 69-92.
[5] Hilali S. (1995). Etude de la flore adventice des vergers d’agrumes du périmètre irrigué du Haouz central (Marrakech, Maroc). Croissance, phénologie et réserves glucidiques-cas du Cyperus rotundus L. Thèse pour l’obtention du diplôme d’étude supérieure de troisième cycle.200p.
[6] Index phytosanitaire Maroc (2017). Association marocaine de protection des plantes. Rabat, Maroc, 304p.
[7] Walai L. D. E., Skiredj A. and Elattri H. (2003). Le bananier, la vigne et les agrumes. Bulletin de transfert de technologie en agriculture au Maroc 109.
[8] MokriniF., JanatiS., AbbadAndaloussiF., EssariouaA., Houari A. and ShaghiM. (2018). Importance et répartition des principaux nématodes phytoparasites des agrumes au Maroc. Rev. Mar. Sci. Agron. Vét. (2018) 6 (4). Pages:558-564
[9] Taleb A., Rzizi S.R and Ouhamou M. (1996). Flore adventice des vergers d’agrumes du Haouz central, aspect floristique. Actes des Journées nationales, scientifiques et technique sur les agrumes au Maroc, IAV Hassan II. Agadir du 23 au 25 février 1996. Pages: 306-313.
[10] Talibi A. (1999). Diversité et importance des mauvaises herbes des vergers d’agrumes dans le périmètre irrigué de la basse Moulouya. Mémoire de troisième cycle pour l’obtention du grade d’ingénieur d’état en agronomie. 65p.
[11] Tucker D.P.H. and Singh M. (1993). Citrus Weed Management. Fact Sheet HS-164, June 1993. Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
[12] WAHBI M. & TALEB A., 1995. Mauvaises herbes des vergers d’agrumes dans la région du Souss : Aspects botaniques et agronomiques. AMPP : Protection desagrumes, Rabat 14-15 mars 1995. Pages: 30-41.
[13] Onyegbule UN., Okpara, SC., Nwanguma EI., Ngbede SO., IbekeweHN., and Uwalaka, AO. (2014). The effect of different weed management methods on the growth Performance of Rough Lemon Citrus Rootstock (Citrus jambhiri (L) Lush) In Okigwe, Southeast, Nigeria. Sci-Afric Journal of Scientific Issues, Research and Essays Vol. 2 (2). Pages: 80-82.