Performance Evaluation of Different Irrigation Scheduling Methods for citrus orchard in Triffa Plain North- East of Morocco

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Abstract— Shortage of canal water is one of the major limitations in the Moroccan irrigation system for increasing agricultural productivity. One of the options for future water needs is to use available water resources more efficiently and effectively. Drip irrigation is introduced primarily to save water and increase the water use efficiency in agriculture, it has the distinct advantage over surface irrigation methods, due to more constant, uniform and complete wetting of effective rootzone of the plant. This study attempts at reviewing the effect of drip irrigation on the chlorophyll content, the fruit size and the yield of Clementine trees (Citrus clementina variety Nules) in Triffa's irrigation perimeter in Eastern Morocco, known by severe water scarcity and a high agricultural activity dominated by the citrus (representing 16 % of the area of Morocco's citrus).

A field experiment was conducted during agricultural campaign 2017/2018 on different arrangement of emitters in surface micro irrigation system in 5 years old Clementine trees on rootstock volkameriana (Citrus × volkameriana). Four different treatments were used; full treatment irrigated during the watering season to provide trees with their full water requirement based on ETc calculations. Deficit treatments irrigated with irrigation water quantities that cover 100%, 80% and 60% of ETc and farmer method irrigated according to farmer irrigation practice. Trees were planted at spacing of 2m×5 m and irrigated with drip line with four drippers per tree (1 L / h).

Data obtained through this investigation mention diversified results according to the experimentation site considered. Generally, Initial results showed that the high value of the chlorophyll content was recorded with 100% of ETc. Furthermore, a reduction of the irrigation dose by 20% in relation to the climatic demand does not affect most of the production parameters, in particular the yield of fruit, the final caliber. The stressful strategy 60% Etc, recorded the lowest average value of 137 fruits per controlled tree compared to the other irrigation strategies adopted. The present study encourages drip irrigation installation companies and researchers for further studies on design, installation and evaluation of different drip irrigation systems for citrus orchards and other valuable crops.

Index Terms— Water, Clementine trees, Triffa, drip irrigation, yield, Chlorophyll content**,** Fruit seize, Morocco.

1 INTRODUCTION

Water is necessary for citrus trees (or for any plant), it is an integral component of the biochemical reactions that occur within the plant. It is responsible for the movement of plant nutrients and other substances throughout the tree. Water also keeps plant temperature through transpiration process. It helps maintain leaf and fruit turgidity [1]. Irrigation is an important component of commercial production in most citrus producing regions of the world, it helps to adequately replenish soil water lost through evaporation and transpiration. Irrigation practices can affect the quality and quantity of fruits [2].

The present work examined the response of chlorophyll content, fruit size and yield of clementine trees to drip irrigation systems applied to define the best irrigation program based on deficit irrigation.

2 MATERIAL AND METHODS

2.1 Field study

This study was conducted in Riad Clémentine a commercial orchard 475 ha of mature Clementine trees (*Citrus clementina* variety *Nules*) on Volkameiana rootstocks (*Citrus* × *volkameriana*), in Northeastern Morocco (34°59'9.8'' N, 2°23'8.4''O, elevation 81m). Trees were planted 5 years ago, spaced 5 m x 2 m, and were irrigated with drip line with four drippers per tree (1 L/h). Each tree is equipped with 12 drippers or 12 L / h / tree. The area affected by each dripper is 5m * 0.5m = 2.5 m^2, the hourly rainfall calculated:

Hourly rainfall (mm / h) = Flow of the drippers (L / hour) / the mesh of the device (m^2) = 2.5 mm / h.

The soil is a loamy clay, isohumic modal brown typical deep. The climate is typical of arid areas with an average annual precipitation of 300 mm. Four irrigation treatments were applied: full treatment (FI) irrigated during the watering season to provide trees with their full water requirement based on ETc calculations. Deficit treatments irrigated with irrigation water quantities that cover 60%, 80% and 100% of ETc and irrigation method according to farmer irrigation practice.

The trial involved a total of 116 trees distributed over the four lines, or 29 trees per irrigation strategy. The 29 trees are divided into 3 blocks in such a way that each block has from 9 to 10 trees of which only 3 trees will be controlled.

2.2 Chlorophyll content

The chlorophyll content is measured using a SPAD-502PLUS chlorophyll meter, having a measurement range of -9.9 to 199.9 SPAD elements.

2.3 Fruit size and yield

The size of the fruit was measured once again after harvest. 20 fruits per irrigation strategy were taken randomly to determine the effect of the irrigation regime applied on the final caliber of Clementine fruit. The last measured production parameter is the final yield of trees by irrigation strategy. It is calculated from the following formula:

Yield (kg / tree) = Number of fruits per tree * Average unit weight of the fruit

3 Results and Discussion

3.1 Chlorophyll content

The analysis of the data resulted in the result which confirms the absence of the effect of the amount of water added on the chlorophyll content; this is based on the value of the meaning evoked by the SPSS software which is greater than the significance threshold (α = 0.05). The average values of the chlorophyll content vary between a minimum of 69.53 CCI recorded in the stressor strategy 60% of ETc and a maximum of 105.15 CCI recorded in the treatment adopted by the producer (Fig.1).

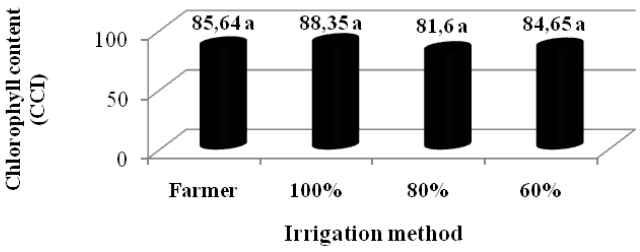

Fig 1. Effect of irrigation treatment on chlorophyll content

A study on the effect of irrigation treatments on leaf chlorophyll content and certain soil characteristics of the native common bermudagrass (*Cynodon dactylon L.*) showed that excessive irrigation reduces leaf chlorophyll content. Therefore, optimal irrigation may increase chlorophyll content [3];

3.2 Fruit size and yield

The daily evolution of the caliber of the fruits is done according to curves of tendencies with different gaits. The fruits under a regime adopted by the producer evolve in a stable and constant way. On the other hand, we find that the most deficient 60% ETc system shows upward and downward fluctuations, but always remains lower than the daily evolution of the fruits under the regimes corresponding to 80% of ETc and 100% of Etc (Fig.2).

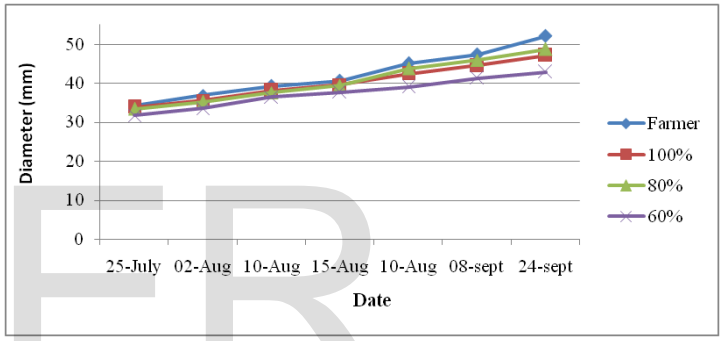

Fig 2. Evolution of the average fruit size

Regarding the final fruit size, the analysis of the variance resulted in the absence of the effect of the irrigation dose applied on this parameter. The lowest average size is recorded in 100% ETc, it is of the order of 58.78 mm. While, the most restricted strategy records the average value of the highest caliber with a mean of 69.78mm (Fig.3A).

As for the production parameter (final yield), the results were almost identical after the completion of a statistical analysis. The responses were negative following the application of water stress. Otherwise, tree productivity was not affected by the irrigation dose. For the final yield, the graph in Fig.3B, showed average values that exceed 20Kg per tree corresponding to the producer's treatment, 100% Etc and 80% of ETc, then the lowest average 14,9 Kg registered in the stressful treatment 60% of Etc.

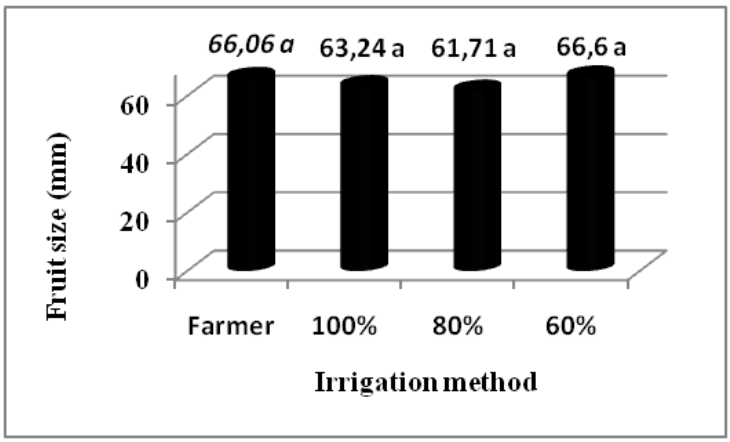

Fig 4. Effect of irrigation treatment on final fruit size (A)

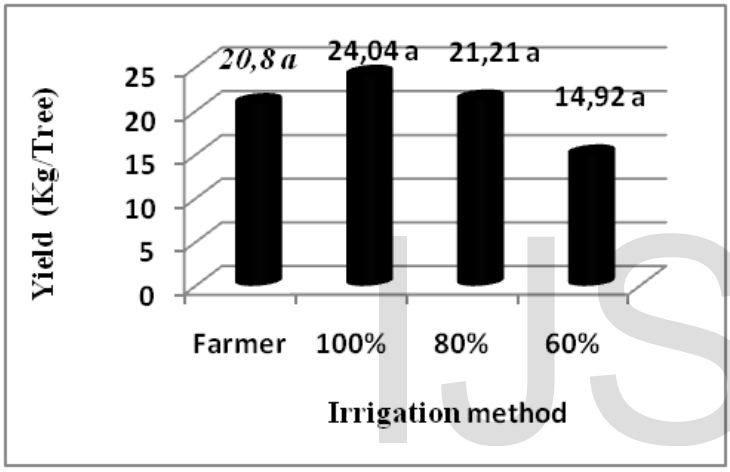

Fig 3. Effect of irrigation treatment on yield (B)

A similar study was conducted on Navel variety grafted on Citrange Troyer of the Gharb region by the team BENIKEN et al. (2008). Concerning the production parameters and according to the same study, the evolution of the diameter and the final size of the fruits are closely related to the watering dose, these parameters are improved by the increase of the dose, however, the results of the final caliber are consistent with those obtained in the BENIKEN et al. (2008) [4], this is well confirmed by the conclusions drawn in the study of BOUAZZAMA et al. (2008) where it could be deduced that the increase in the diameter of the fruits is favored by the inflow of water during the summer grow-out stage of the "Maroc Late" variety [5]. Similarly, SNOUSSI. (1994) reported that for oranges (Valencia Late) and Clementine (Nour) the reduction in the amount of water brought and the load on the tree affect negatively the final fruit size and yield [6].

4 Conclusion

This study has shown that the application of 80% dose ETc meets trees needs without affecting yield, desired fruit size, and chlorophyll content.

Acknowledgment

Grateful thanks are expressed to the Organizing Committee of The International Conference of Scientific Research and Doctoral Studies; ANOU Abderrahmane, Université Saad Dahlab Blida 1, Algerie, BABOUNIA Aziz, UIT, Kenitra MOROCCO, BOUREKKADI Salmane , ARSED, MOROCCO, FAKHRI Youssef, UIT, Kenitra MOROCCO, KHOULJI Samira, UAE, Tetuan MOROCCO and RAFALIA Najat, UIT, Kenitra MOROCCO for their enormous cooperation in the organization of this successful and highly stimulating conference.

Thanks to the Professors of the Faculty of Sciences of Oujda, the National School of Agriculture Meknès, and the staff of the Riad Clementine orchard.

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