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Influence of supplemental irrigation in the production of 3 varieties of tomato at the Goudoumaria experimental station (Diffa-Niger)

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ABSTRACT: In the Sahel, irrigated agriculture through market gardening activities occupies a key place in the socio-economic life of populations but food insecurity remains a persistent reality. The solution to deal with this delicate situation which occurs every other year (2), would be to resort to intensive irrigated production of market garden crops intended for consumption, such as the case of tomatoes (Solanum lycopersicum L.). This study was carried out on the experimental site of the departmental directorate of agriculture of Goudoumaria.
The aim is to analyze the impact of complementary irrigation on the growth and productivity of three (3) tomato varieties in experimental trials conducted at a research station. These varieties are: F1 Mongal, Roma and Rio Grande with two (2) supplementary irrigation regimes with 2 treatments (T1: with supplementary irrigation in the absence of rain for 3 successive days and T2: without supplementary irrigation or Control, the plants receive as rainwater). The following parameters were measured over time: germination rate, growth parameters (height, number of leaves, stem diameter) and production. The results showed that supplementary irrigation improves the production of 3 tomato varieties from the first harvest with respective yields for F1 Mongal=9.216t/ha, Roma 16.464t/ha, and Rio Grande, 10.368t/ha.
As for the controls (T2), the yields are 6.336t/ha (F1 Mongolian), 7.392t/ha for the Roma variety, 6.3t/ha (Rio Grande). These varieties are therefore well suited to supplementary irrigation and constitute a solution to the food and economic deficits of the population, especially since these varieties are well palatable to humans and very nutritious.
To perpetuate this activity, which is beneficial to irrigators in the study area, the State must support them; only the means of drainage and wells or market gardening boreholes remain.

KEYWORDS: Supplemental irrigation, irrigated agriculture, food insecurity, tomato varieties and Goudoumaria experimental site.

1 INTRODUCTION

Food insecurity is not a new reality for Africa. For more than twenty years, the continent has been struggling with hunger and food insecurity. Food security prevails when "all people, at all times, have economic, social and physical access to sufficient, safe and nutritious food that meets their nutritional needs to enable them to lead active and healthy lives". (FAO., 2011). Food insecurity therefore exists when food is not available, when individuals or households do not have the means to obtain it, when it is not available at all times, and when individuals or households do not have the opportunity to consume them.

Niger is one of the most vulnerable countries in the world due to the context linked to its climate, its environment and its economy. In Niger, the performance of the agricultural sector is nevertheless very unstable due to its high exposure to climate change (ABDOUL HABOU et *al*., 2016). Indeed, aware of the need to specifically tackle agricultural problems in all their aspects, researchers from the National Institute of Agronomic Research of Niger, agricultural executives and those from Abdou Moumouni University provide an overview of the constraints of agricultural production and propose some areas of intervention to remedy them. According to Clark (2006), the most effective and sustainable adaptation measures are often those taken at the local level directly involving the people affected. The adaptation practices developed by producers in response to the negative consequences of climate change depend on the perception and endogenous knowledge they have of these changes (Dimon., 2008).

Sahelian soils are characterized by a low level of fertility, which is improved by spreading organic manure or fertilizer. However, household economic constraints limit their adoption (Manssour et *al*., 2014). According to (Ramasamy and Moorthy., 2012), low agricultural productivity exacerbates the incidence of poverty and hunger, which means that whatever their causes, poverty and food security are closely linked (Rukhsana., 2011). The Diffa region, despite its strong agricultural potential, is experiencing a serious food crisis due to insecurity; agricultural production has fallen over the last 10 years. It is in this sense that market gardening must face significant challenges today.

It is in this sense that this study is carried out in the rural commune of Goudoumaria with the objective of analyzing the impact of complementary irrigation on the production of three (3) varieties of tomato mentioned above.

2 Presentation Of The Study Area

Located in the western part of the Diffa region, the commune of Goudoumaria is bordered to the south by the State of Yobé (Federal Republic of Nigeria), to the east by the commune of Mainé Soroa and N'GuelBeyli, to the north by the commune of Tesker and that of Kellé and to the West by the commune of Gouré. The commune of Goudoumaria covers an area of 6915 km^2 (PROLAC., 2022).

It is in this sense that this study is carried out in the rural commune of Goudoumaria with the objective of analyzing the impact of complementary irrigation on the production of three (3) varieties of tomato mentioned above.

The figure above represents the Diffa region, with details on the department of Mainé Soroa and the commune of Goudoumaria.

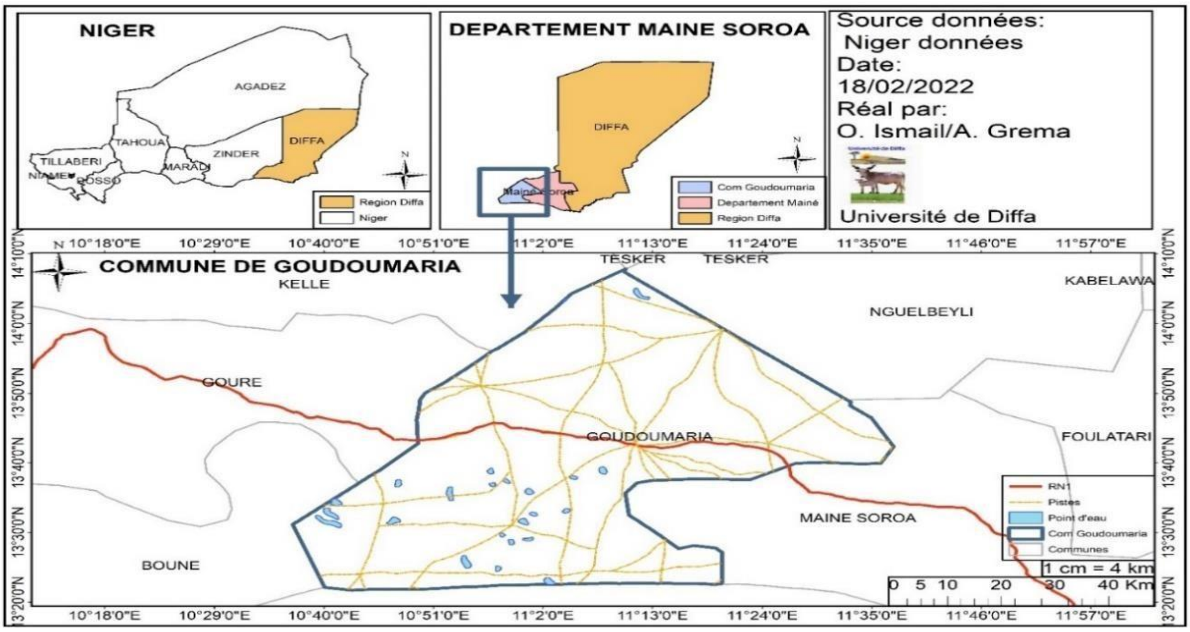

Fig. 1. Location map of the department of Goudoumaria (Fadel., 2024)

2.1 Material And Methods

2.2 Material

2.2.1 Vegetal Material

The vegetal material used consists of seeds of the tomato variety: F1 Mongal, Rio Grand, and Roma.

2.2.2 TECHNICAL MATERIAL

Wooden stakes were used to demarcate the different plots, and to serve as a support for marking the plants to follow in each plot. In order to easily identify the plants monitored in the different plots, they were marked using labels on a metal stake, the plots are labeled from A to D for each variety. Thus, sheets for monitoring the emergence and monitoring the growth cycle of the identified plants were designed. A graduated ruler and a metric tape (m) were used for measurements. To evaluate production, plastic cups were used to harvest the tomatoes, a graduated ruler, large plastic envelopes, and a digital scale were used. A watering can is used to irrigate the plots which had received additional water.

2.2.3 STUDY SITE

This study took place at the experimentation site of the Goudoumaria Departmental Directorate of Agriculture (DDA) located in the city center of the CRG opposite the Goudoumaria prefecture. Its geographical coordinates are: 13°70’91” North Latitude and 11°18’48” East Longitude (photo2).

Fig. 2. Plan of the farm of the experimentation site of the departmental directorate of agriculture of Goudoumaria (DDA)

2.2.4 EXPERIMENTAL DEVICE

The tests were installed on a 150m^2 plot with an area of 15m x 10m comprising elementary plots on previously plowed soil. The device is made up of 3 repetitions, each of which is made up of 6 plots of 6m^2 (3m x 2m) in area. These plots were separated by 0.5m alleys. For each variety, we therefore have 2 plots of 6 m^{2,} one of which will receive supplementary irrigation every 3 days without rain (supplemental irrigation, this is treatment T1) and the plot water will only receive water of rain therefore without irrigation (this is treatment T2).

For the 3 varieties (Mongal variety, Rio Grand and Roma variety): The spacing between the rows is 30 cm and the spacing between the pockets is also 30 cm, i.e. a density of 110,889 pockets per hectare.

2.3 METHODS

The ground was well plowed before installing the boards. These beds were watered for a week for the decomposition of the bottom manure.

The trials were set up for all three tomato varieties at the start of the rainy season in July 2024. Direct row sowing was done on July 20, 2024 following a density of 0.3m × 0.3m in each plot of 6m2.

2.3.1 IRRIGATION

Board to board irrigation and an irrigation mode that we had adapted for the conduct of our experiment. It consists of using a hand watering can to irrigate the beds which had been subject to additional irrigation.

The beds are cross-irrigated, hence the randomization of the treatment. During the entire period of the experiment, additional water was added every three (3) days without rain.

2.3.2 SAMPLING

In each plate, two individuals were randomly selected as monitoring subjects throughout the experimental period, i.e. twelve individuals in each culture.

2.3.3 OBSERVED PARAMETERS AND MEASUREMENT TECHNIQUES

Emergence monitoring was carried out every day from the day the first seedling appeared from the soil.

To evaluate production, all fruits on each plot and in each treatment are harvested... Days after sowing (DAS). These fruits were weighed to determine the fresh weight, then a sample was taken and dried in the sun for a week to determine the dry matter. The dry matter content is obtained by the following formula:

$$\mathbf{PST} = \frac{PSE}{PFE} \times PFT$$

PST: Total dry weight; PFE: fresh weight of the sample; PSE: dry weight of sample.

Dry production per hectare is then obtained by extrapolation.

3 RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1.1 PERCENTAGE OF LIFT

F1 MONGAL VARIETY

The observation of sowing seeds at emergence depending on the treatments (figure 3) shows that emergence began 4 days after sowing and continued until the 10th day after sowing. We thus obtain a emergence percentage going from 38 to 96% for treatment 1 and from 26 to 90.66% for treatment 2. However, throughout the decade of the nursery, the best results were obtained with treatment T1. This is due to the additional irrigation done twice during this decade for treatment T1.

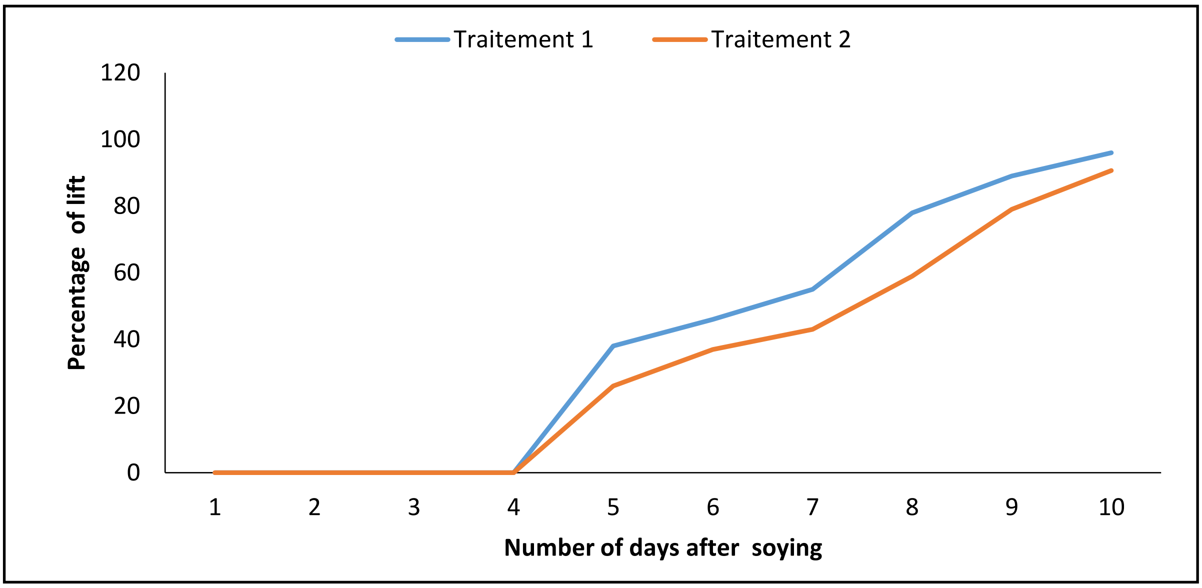

Fig. 3. Percentage of emergence of the F1 Mongal variety with supplemental irrigation (T1) and without irrigation (T2)

Roma Variety

For the Roma tomato variety, the observation of emergence depending on treatment (Figure 3), shows that it began 3 days after sowing (DAS) and continued until the 11th day going from 23.11 to 80% for treatment 1 and 20.33 to 75.33% for treatment 2. However, during the emergence period, its percentage at the level of the beds of treatment 1 is slightly higher than the rate of germination in the treatment beds2.

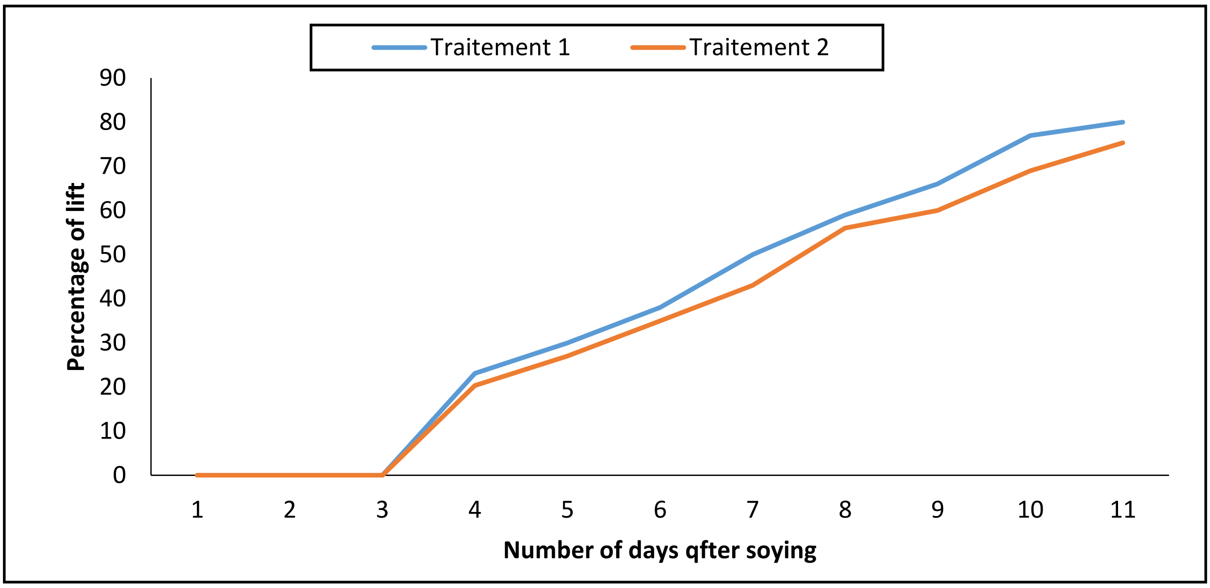

Fig. 4. Percentage of emergence of the Roma variety with supplemental irrigation (T1) and without irrigation (T2) Variété Rio Grande

Concerning the percentage of emergence of the Rio Grande variety, Figure 4 shows that it began 4 days after sowing and continued until the 10th day going from 22.22 to 86.66% for the treatment 1 and from 16.67 to 70.37% for treatment 2. During this period, we observed that it is more important with T1 than T2.

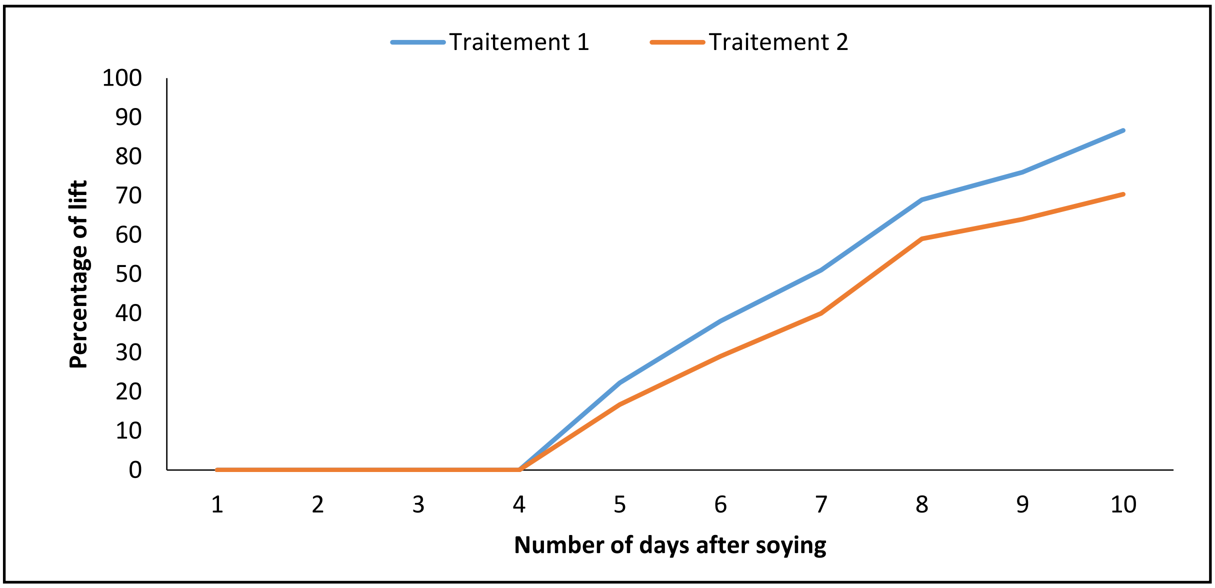

Fig. 5. Percentage of emergence of the Rio Grande variety with supplemental irrigation (T1) and without irrigation (T2)

Therefore, it appears that complementary irrigation (supplemental irrigation) influences the emergence and germination of the tomato, whatever the variety considered in the case of our experiment.

Figure 5 illustrates the production of tomato varieties F1 Mongal with supplemental irrigation (T1) and without irrigation (T2). It appears from this figure that supplementary irrigation has a significant influence on production. Thus, the production obtained with treatment T1 (76.8t/ha) exceeds more than twice that obtained with the control without irrigation in T2 (28.8t/ha). After drying for conservation, the productions are respectively 9.22 t/ha and 6.34 t/ha for the two treatments.

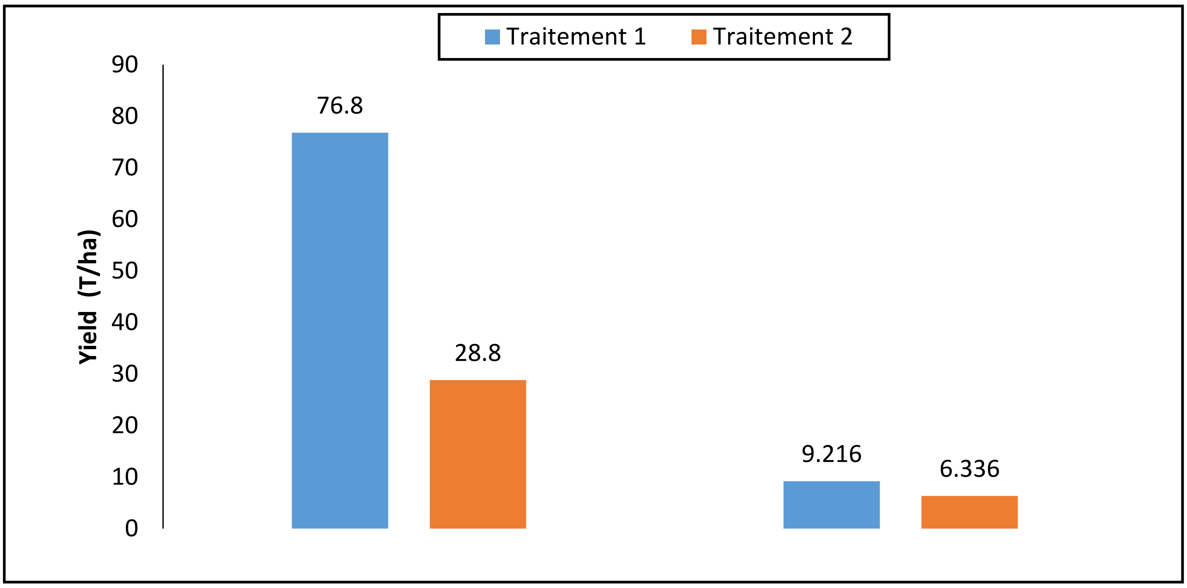

Fig. 6. Production of tomato variety F1 Mongal with supplemental irrigation (T1) and without irrigation (T2)

Roma Variety

Figure 6 shows that at the first harvest of the Roma variety, supplemental irrigation greatly influences production. The production obtained with treatment T1 is double that obtained with the control without irrigation in T2. They are 105.6t/ha and 67.2t/ha respectively for treatments T1 and T2. Once the tomatoes have been dried for conservation, the productions are respectively 16,464 t/ha and 7,392 t/ha for the two treatments.

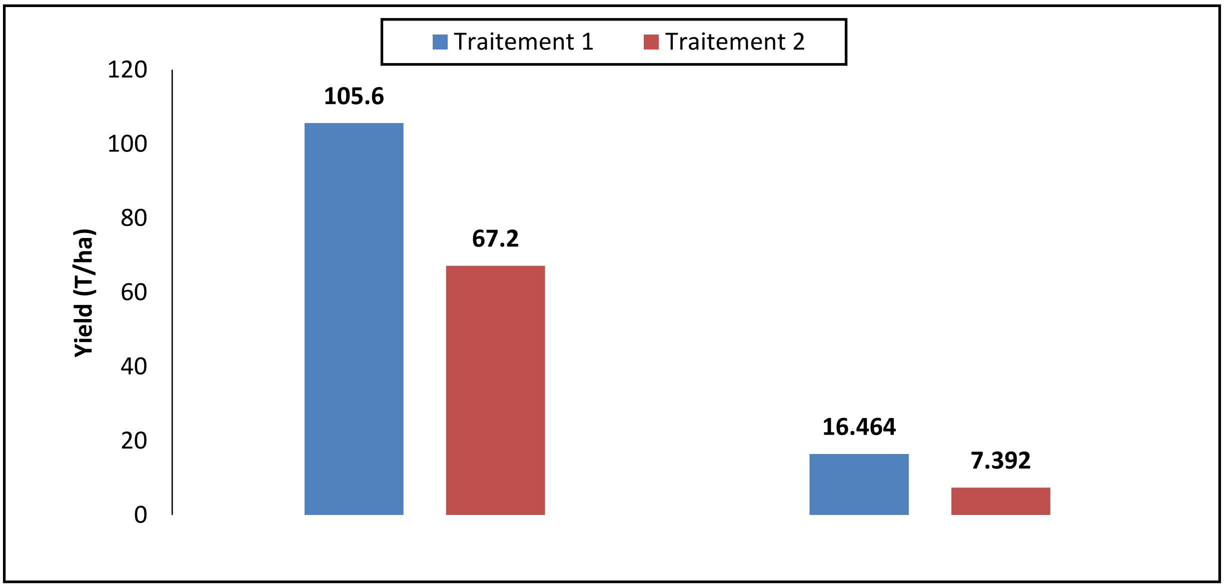

Fig. 7. Production of tomatoes of the Roma variety with supplemental irrigation (T1) and without irrigation (T2)

Rio Grande Variety

As for the Rio Grande variety at the first harvest, Figure 7 shows that supplemental irrigation also influences production. The production obtained with treatment T1 (86.4 t/ha) far exceeds that obtained with the control without irrigation in T2 (63 t/ha). After drying these productions for conservation, the latter fell respectively by 10.37 t/ha (T1) and 6.3 t/ha (T2).

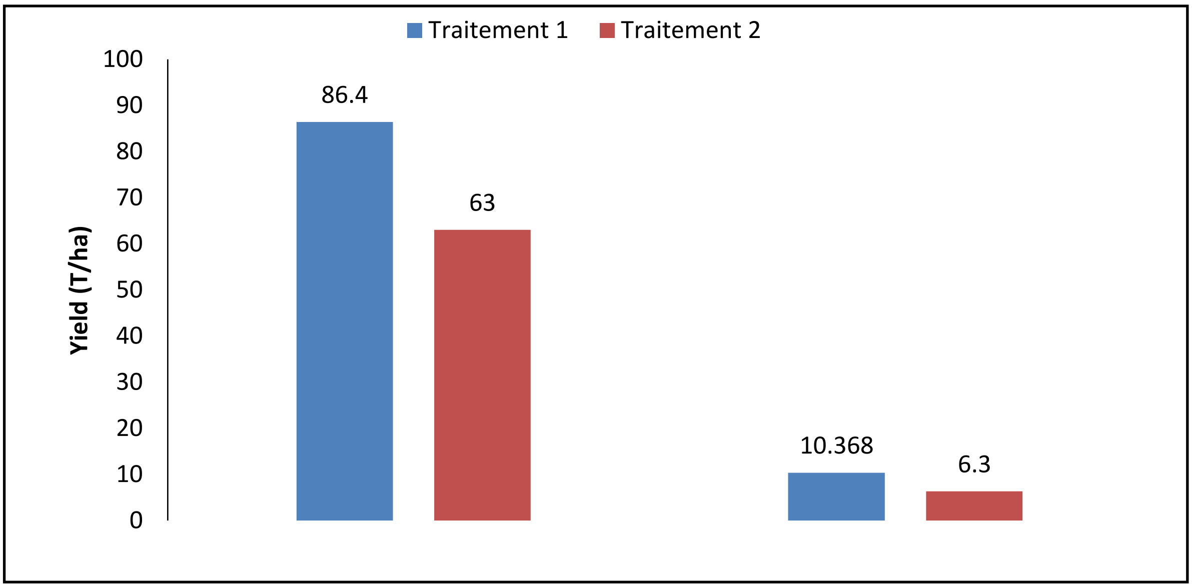

Fig. 8. Rio Grande variety tomato production with supplemental irrigation (T1) and without irrigation (T2)

3.2 Discussion

3.2.1 Ten-Day Monitoring Of The Lifting

For the 3 tomato varieties, emergence began at the same time for all treatments. The start of the first emergences was recorded 3 to 4 days after sowing. For the F1 Mongal variety, the emergence percentages obtained are 96% with a nursery with supplementary irrigation for treatment 1 and 90.66% for a nursery receiving rainwater only. For the Roma tomato variety (80% for treatment 1 and 75.33% for treatment 2) and the Rio Grande variety (86.66% for T1 and 70.37% for T2) which are lower than those obtained by KITABALA et al. (2016) and HASSAN (2024) which respectively obtained lifting percentages of (83% and 87%).

Our results are different from those obtained by BOUABDELLI et al. (2021). This author obtained 82.50% of the seeds which emerged. Although the variety he used is one of the 3 varieties we used, this difference would probably be due to the supplemental irrigation we did and the period during which the trials were conducted. He conducted his experiment in hot weather. Its results are lower than those we obtained with the control, which was also lower than the T2 treatment. The quantity of water it would have would be lower than that of our control watered by the rains which in turn would be lower than our supplemental irrigation treatment. In fact, the latter receives both rainwater and additional water in the event of water stress.

3.2.2 Production

For the varieties Roma, Mongal F1 and the Rio Grande variety, the irrigation and control productions are respectively (105.6 t/ha and 67.4 t/ha), (76.8 t/ha and 28.8t /ha) and (86.4t/ha and 63.3t/ha). However after harvest, whatever the variety considered, the production of treatment 1 is significantly higher than that obtained with treatment 2. This superiority in production is due to the differences in emergence percentage recorded with the supplementary irrigated nursery and that watered only by rainwater. Several studies have already affirmed that the pocket of drought observed by cultivated plants has an influence on the yield of legumes (Nadeem et al., 2019).

However, the results obtained in this study are far superior to those obtained by GARANE et al. (2019) of 19.04 t/ha. This difference could be explained by the study environment or even by the conduct of the tests. This difference could be explained by the nature of the soil, the environment, or even by the progress of the trial, by the productive capacity and adaptation to the rainfall conditions of the study region of each of these different cultivated varieties.

4 CONCLUSION

This study showed that supplemental irrigation improves the yields of varieties like F1 Mongal, Roma, and Rio Grande. These varieties develop well in these conditions of complementary water supply and give satisfactory production. Thus, given the production capabilities of these tomato varieties in such conditions, these plants appear as crops to be promoted to alleviate food insecurity and improve the economic conditions of the population which are one of the most big problem in the Sahel. Additional studies will be necessary to study the effects of sowing densities and fertilization on the production of these varieties.

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