IMPACT OF IRRIGATION WATER ON SOIL BACTERIAL COMMUNITIES

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Abstract

Soil microbial communities in agricultural ecosystems are affected by soil type, climate conditions, plant species, and crop management (i.e. soil tillage, fertilizers, plant protection products, irrigation management). To highlight the influence of irrigation water on soil bacterial communities in maize (*Zea mays* L.), soil sample were taken in four growth stages of maize crop, between May and August 2022. The dynamics of bacterial community during the vegetation period show an increase from May to July and a slight decrease until the end of August. Our result suggest that irrigation water has a positive impact on bacterial communities in soil, being an additional reason to invest and use irrigation systems in agriculture.

Key words: soil microbiota, maize, soil bacteria communities

The microbial community is an essential component of the soil and plays an important role in maintaining the ecological functions of the soil. It is directly involved in nutrient cycling, energy flow, and degradation of organic matter.

Soil microbial communities are very sensitive to soil changes, such as disturbances due to soil tillage, agronomical practices, and irrigation water (Frank S. *et al*, 2014).

The microbial community composition of agricultural soils is influenced by a number of different factors. Through the physical, chemical and biological factors considered to influence the structure of the soil microbial community are found: soil types (Schreiter S. *et al*, 2014; Marschner P. *et al*, 2004; Girvan M.S. *et al*, 2003), soil texture (Hamarashid N.H. *et al*, 2010; Chau J.F. *et al*, 2011), soil aggregate size (Steinberger Y. *et al*, 2022; Trivedi P. *et al*, 2015), soil moisture (Borowik A. *et al*, 2016; Chen M.M. *et al*, 2007), soil pH (Petri J.A. *et al*, 2008; Zhalnina K. *et al*, 2015), soil temperature (Alkorta I. *et al*, 2017), agricultural management factor, such as tillage systems (Mathew R.P. *et al*, 2012), fertilizers and amendments (Goyal S. *et al*, 1999), crop species (Mackie K.A. *et al*, 2014), and also irrigation water (Li H. *et al*, 2021).

The main purpose of the present research was to investigate how the structure of microbial communities from chernozem soil type is affected by irrigation water and season in maize crop.

MATERIAL AND METHOD

In this study, the soil samples were taken from the northeastern region of Romania, Iași county, Andrieseni village.

The soil of the experimental field is classified as chernozem (according to WRB soil classification).

The soil samples were taken from three agricultural plots cultivated with maize and irrigated (V1, V2, and V3), and the control variant of the study was represented by the sample taken from an agricultural plot also cultivated with maize, but not irrigated, the plot found near the irrigated plots (V4 control). In the case of all plots cultivated with maize, the cultivation technology was identical (*figure 1*).

From each plot cultivated with maize, 10 points were randomly selected from where soil was taken, so that the entire area of the plots was covered.

Soil samples were taken from a depth of about 7-10 cm, using sterile paper bags and sampling tools, also sterile.

The soil samples were taken four times during the vegetation period of the maize crop, between May and August 2022.

Soil samples were transported to the microbiology laboratory, stored overnight at 4^0C, dried at room temperature and sieved (2-mm mesh) prior to further use in the experiment.

The total numbers of bacteria of colony forming units (CFUs) were determined by serial dilution and plating into nutritive media on potato dextrose agar medium (PDA) in different compositions: classic and with streptomycin. Streptomycin antibiotic (35 $mg \cdot L^{-1}$) was used to control the reproduction of Gram negative bacteria.

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From the collected samples, successive dilutions were made in sterile water, using a dilution coefficient in the rate of 10 (dilutions 10^{-1}, 10^{-2},..,10^{-6}). By this technique a series of dilutions are obtained in which the number of germs decreases in arithmetic regression. To prepare these dilutions, 9 ml of double-distilled water sterilized at 120°C for 30 minutes was distributed in sterile tubes of 15 ml capacity. Weighed 1 g of soil onto a sterile watch glass and placed it in the first dilution tube. After vigorous stirring for five minutes a 10^{-1} (1/10) dilution was obtained. From this dilution was taken with a sterile graduated pipette, 1 ml of suspension and transferred to another test tube with 9 ml of sterile water, obtaining the dilution 1/100 (10^{-2}). In the same way the other dilutions were obtained: 1/1000 (10^{-3}), 1/10000 (10^{-4}), 1/100,000 (10^{-5}) and 1/1,000,000 (10^{-6}). Under aseptic conditions, plating was made from the obtained dilutions, introducing 1 ml of suspension from each dilution into a Petri plate.

After incubation period at the thermostat (24 h at 28^0C), the colonies were counted. With the help of the Wolfhügel plate, the colonies of bacteria from 15-20 surfaces of one cm^2 taken on the two diagonals of the Petri plate were counted. To calculate the number of colonies on the entire surface of the plate, the average number determined per cm^2 was multiplied by the surface area of the plate in cm^2. To determine the number of bacteria in one gram of soil, we multiply the number of colonies that developed in a Petri plate by the inverse value of the dilution. The count result is related to the dilution used and the final result is expressed in colony forming units (CFUs) per 1 g of soil.

Figure 1 **Soil sampling locations.**
The white circles represent the area covered by one irrigation pivot.

RESULTS AND DISCUSSIONS

Some studies on the impact of irrigation water on soil microorganisms have shown that they have a positive effect on soil microbial growth, survival and activity (Entry J.A. *et al*, 2008).

Following the influence of irrigation water and vegetation period on the numerical density of soil bacteria it is observed that the dynamics of bacterial community during the vegetation period show an increase from May to July and a slight decrease until the end of August (*figure 2*).

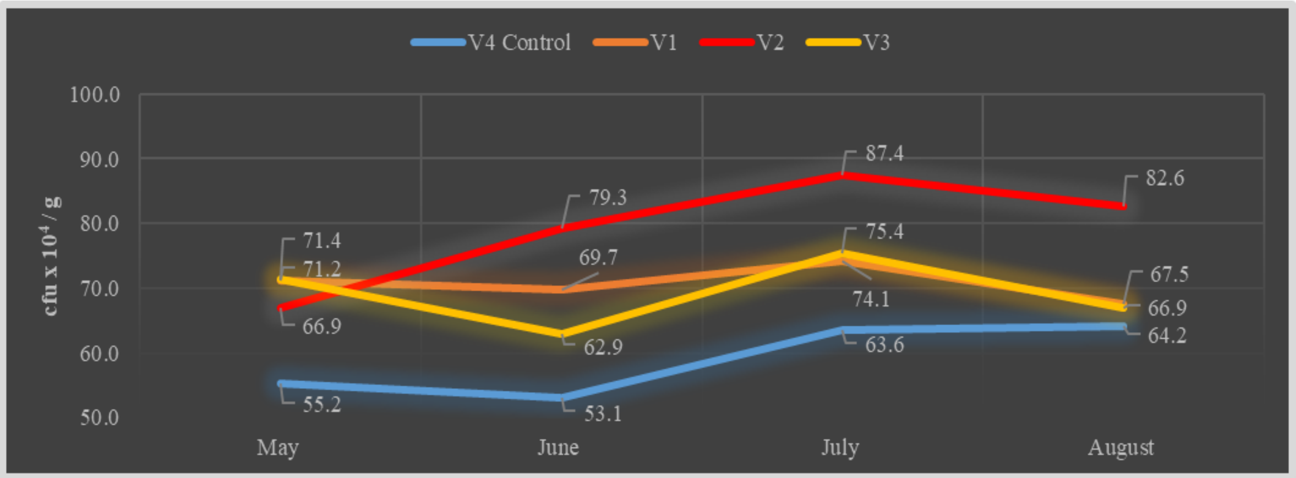
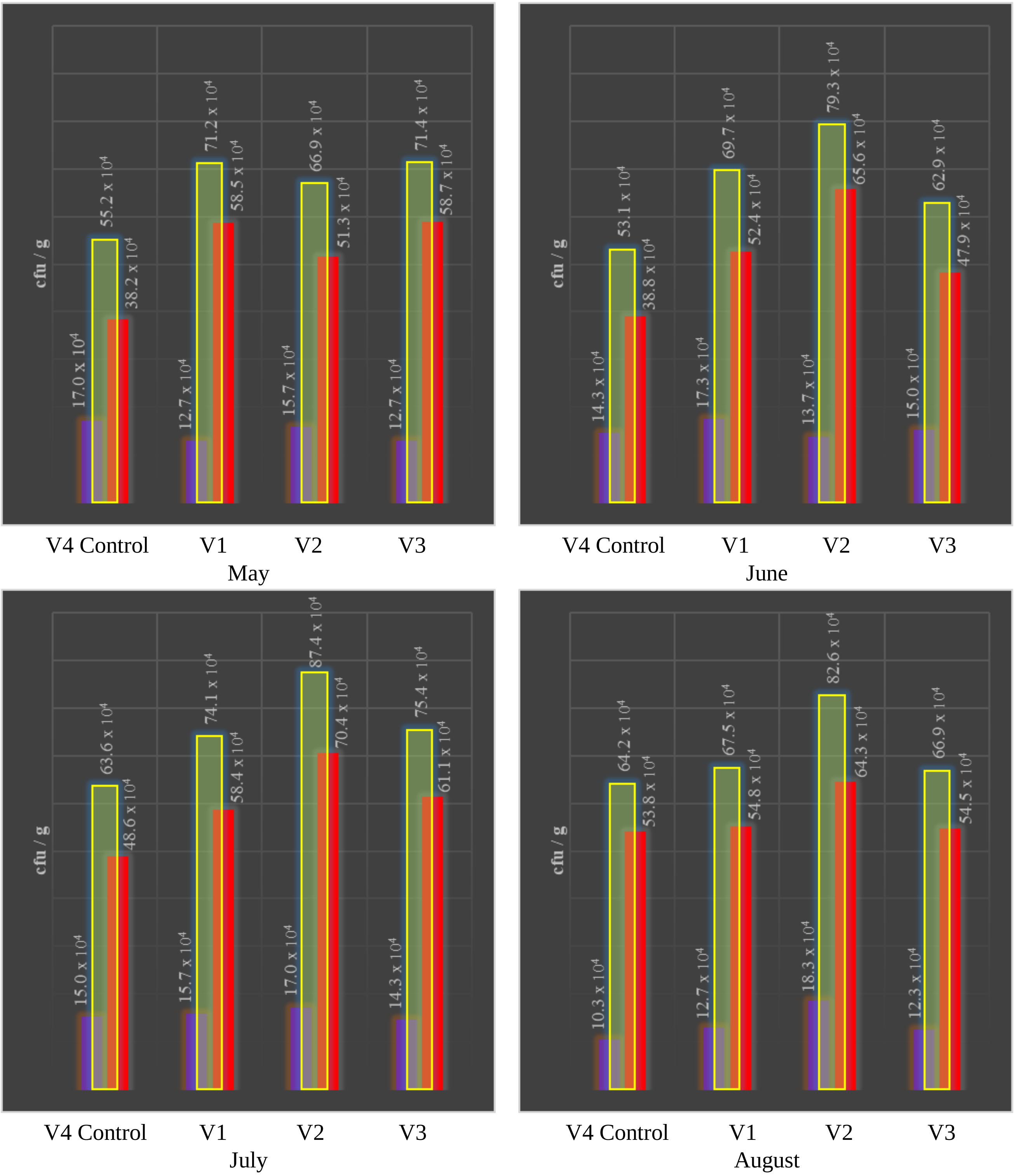


Figure 2 **Changes of soil bacterial communities during the vegetation period of maize crop**

Analyzing the results, it is observed that during the vegetation period, under the influence of irrigation water, the numerical density of bacteria was higher in all cases where the maize crop was irrigated, compared to the variant in which the maize crop was not irrigated (*figure 3*).



Yellow column – Total number of bacteria / g^{-1}
Purple column – Gram-positive bacteria / g^{-1}
Red column – Gram-negative bacteria / g^{-1}

Figure 3 **Effect of irrigation water during the maize growing season on soil bacterial communities**

The effect of seasonal variation on soil bacterial communities showed that Gram-negative bacteria dominated soil bacterial communities. Analyzed the numerical density of bacteria under the influence of irrigation water, we noticed that in all cases the number of bacteria was higher. The ratio between Gram-positive bacteria to Gram-negative bacteria was not influenced by irrigation water.

CONCLUSIONS

Following the study, it was observed that irrigation water has a good influence on the numerical density of soil bacteria.

In the case of the control variant (V4) in which the maize crop was not irrigated, the total number of bacteria was between $55.2x10^4/g^{-1}$ and $66.2x10^4/g^{-1}$, with a linear increase from May to August.

In the case of the variants represented by the irrigated maize crop, the total number of bacteria oscillated between $66.9x10^4/g^{-1}$ and $87.4x10^4/g^{-1}$, with a peak in the growth of the microbial density being observed in July, which can also be explained by the fact that in July, the largest amount of water was applied to the maize crop.

These results represent an important starting point for future research on the influence of irrigation water on soil microbiota.

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