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Effect of Fish Drainage Water Irrigation on Soil Productivity

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Abstract

A laboratorial study was accomplished to explore the effect of using fish discharged water in irrigation on soil productivity. *Oreochromis niloticus* and *Claris gariepinus* were used in the study for fish culture, and *Trigonella foenum-graecum, Trifolium alexandrium* and *Vicia faba* were used for the agriculture application. Germination percentage, total N, P and K in plants and soil were determined. Seeds were planted in the same soil into four groups and subjected to four irrigation treatments; irrigation with the supplying water of fish culture (T1), the drainage water of tilapia (T2), the drainage water of catfish (T3), and the drainage water of catfish reared on tilapia drainage water of (T4). Results indicated that soil content of OM% and NH3 changed significantly ($P<0.05$) with the change of treatment and the planted species. A higher productivity was found in T2, T3 and T4 compared to T1, the highest was found in T4 than other treatments. The application of integrated fish culture and agriculture methodology in areas where low fertile soil prevails was recommended.

Keywords: Soil germination; Food security; Freshwater fish; Water recycling

Introduction

Poor soil quality is one of the major problems against spreading green areas and obtaining higher productivity for food security. Assessment of the State of the world's soil resources from based on observations made in the 1980s shows a dramatic degradation of soil all over the world [1]. Irrigation was found to be one of the important factors to reduce soil fertility as it is able to remove several soluble beneficial salts from root zone [2]. The use of waste water in irrigation can result in deleterious effects on soil, humans and the environment as well leading to various changes in the physicochemical and microbiological parameters of the soil, causing accumulation of chemical and biological contaminants in soil which may lead to serious health problems in humans [3].

Many soil improvement approaches have been applied to overcome soil problems; organic matter application to such soils can result in increased water-holding capacity and fertility [4] to obtain higher soil productivity. Bacterial de-nitrification for precipitating carbonate [5], manure additives [6] were found successful as well. Cultivation of cotton in the rotation was also successful as an entry point of nutrients via fertilization to increase soil productivity of the crops [7].

Also, CO_2 application in soil was found able to significantly increase total root production of crops planted in infertile soil, however, it couldn't cause similar effect when applied in fertile soil [8]. Drainage water of fish culture was evidenced to be highly enriched with natural fertilizers [9] due to fish excrete which contains high content of ammonia and urea and organic matter. Recycling such water in fish farming of appropriate different fish species resulted in accumulation of these contents [9] and led to soil quality increase when irrigated by this recycled water.

Thus, in this research, the productivity of soil to cultivate different types of plants species was investigated; irrigation with the recycled water of fish framing was applied to verify the efficiency of such integrative methodology to provide production of crops and fish in parallel.

Materials and Methods

Tilapia (Oreochromis niloticus) and catfish (Claris gariepinus) were reared in different aquaria, and other aquaria for catfish were reared in the drainage water of tilapia aquaria as described by [9]. Seeds of fenugreek (Trigonella foenum-graecum), clover (Trifolium alexandrium), and faba beans (Vicia faba) were brought from seeds market. The seeds were planted in four separate groups in similar soil.

The groups were subjected to four irrigation treatments for 12 weeks; The first group was irrigated with the water used as a supplying water for the fish aquaria (T1), the 2nd group was irrigated with drainage water of tilapia (T2), the 3rd group was irrigated with the drainage water of catfish (T3), and the 4th group was irrigated with the drainage water of catfish which was reared in the recycled drainage water of tilapia (T4). At the end of the interval, determination of E.C. and total organic matter OM% [10] were made to soil, while total NH3 [11], total N, and P [12] and total [13] were made to soil and plants. Data were tested by SPSS 13.0, 2004 multivariate ANOVA (Wilks' Lambda) and LSD at ($P<0.05$).

Results

Generally, results indicated a significant difference between soil contents and germination in T1 and in T2, T3 and T4. A significant interaction between tested parameters and between species in their response towards the change of treatment was shown.

Germination was relatively higher in T2, T3 and T4 compared to T1 in all planted species; germination of fenugreek was higher in T2, T3, and T4 by 40, 38.3 and 48.3% respectively, and 46.2, 48.1, 63.5% for clover respectively, and 37.04, 42.59, 61.11% for faba respectively. However, all species in T4 showed the higher germination (Figure 1).

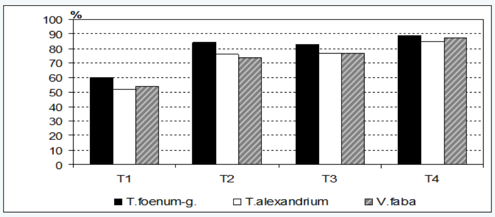

Figure 1: Differences in germination in planted species with treatment.

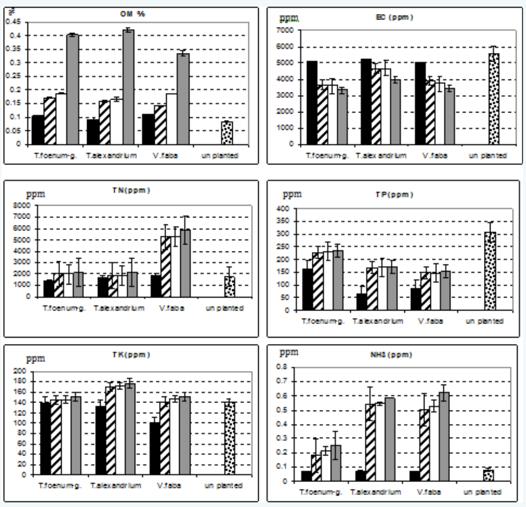

Figure 2: Changes of soil parameters with deferent treatments.

Soil analysis revealed a significant change in soil parameters in T2, T3, T4 compared with T1 as shown in (Figure 2) the change varied from a species to the other, this variation was significantly affected by the type of each planted species; where OM%, total NH3, and total N were significantly increased in all species. However, all parameters were the highest in T4. Meanwhile, no significant difference was found between groups in soil salinity.

Discussion

Germination rates suggested that the type of irrigation water influenced the germination process and that it mostly provided the soil with acceptable amounts of nutrients needed for growth. But, sensitivity to salinity, storing conditions, water requirements and/or time of plantation, drought and temperature might all interfere to cause these differences [14]. However, all these factors should be considered and observed by agriculturists when the system is applied on the real ground.

Total N content was highest in soils planted with Vicia faba in all groups which is mostly due to the Rhizobium bacteria (Phizobium leguminosarum) on its roots which perform enormous Nitrogen fixation in the soil [15]; the variation of water sources in treatments supported the increase of N content in the used irrigation water [16]. Field studies conducted by Sparrow showed that faba bean had the highest N2 fixation rates of all the legume species tested, highest N accumulation, and high total plant N concentration at final harvest. Total NH3 was obviously increased by the treatment which was enriched with NH3 as evidenced by [16]. Meanwhile, total K content was probably reduced in soils sue to the crops consumption. Yet, the level is below medium levels (60 - 120 ppm) as reported by Hasanein [17].

Conclusion

Recycling water in fish culture then in irrigation is not only a method to save water, but it can also be as a source of organic fertilizer to low fertile soils to provide a higher productivity of crops in addition to fish production. It is recommended to field test the experiment to improve the quality of low fertile soils in arid areas to facilitate its cultivation, and to increase its field capacity to protect it from degradation. These outcomes may strongly encourage promoting the living standard of the inhabitants in these areas and provide them with food security of plant and animal proteins.

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