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EVALUATION OF TILLAGE SYSYEMS ON SOIL FUNGUS MICROFLORA UNDER WINTER WHEAT CULTIVATION

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Abstract

Soil fungus microflora promotes aggregation and has an important role in the transformation of relatively variable plant nutrient sources such as nitrogen, phosphorus, and sulfur and in making them useful for the plant. The effect of soil tillage treatments on soil fungus microflora is not fully known. This study was carried out in semi-arid climatic conditions in Diyarbakır in order to investigate the effectiveness of conventional tillage, reduced tillage and direct seeding practices on soil fungus microflora in the 2016-2017 winter wheat cultivation period. Soil samples taken from the rhizosphere of the wheat plant were transferred to nutrient agar and potato dextrose agar medium after dilution in order to determine the changes in the number of soil fungi in detail during the sowing time and flag leaf phenological period. As a result of the study, it was determined that different tillage practices do not make a statistical difference on the soil fungus microflora. However, unlike the soil samples taken in sowing period, it was determined that the number of fungi increased significantly in the parcels subjected to direct seeding during the flag leaf phenological period.

Key words*: soil fungus microflora, wheat, soil tillage, no-till.*

INTRODUCTION

Because microorganisms mediate many processes that support agricultural production, soil microbial activity is important for sustainable agriculture (Lupwayi et al., 1998). Fungi, bacteria and actinomycetes are the main soil microorganisms. Soil microorganisms and enzyme activity are important indicators of soil quality (Pajares et al., 2011). As is known, soil microorganisms and enzyme activity can activate potential soil constituents, which in turn helps increase product yield. Activities that act on soil physicochemical character, such as soil processing methods, directly affect microorganisms and enzyme activity in the soil (Ji et al., 2014). Soil fungus microflora promotes aggregation and has an important role in the transformation of relatively variable plant nutrient sources such as nitrogen, phosphorus, and sulfur and in making them useful for the plant (Shannon et al., 2002; Ghorbani et al., 2008). The soil organic matter promoted by fungal activity increases aggregate stability, cation exchange capacity, water retention capacity, water absorption rate and soil porosity (Nannipieri et al., 2003; Yin et al., 2010).

The effects on soil microorganisms of modern agriculture are quite complex. But understanding them is important for effective and sustainable management of agricultural ecosystems (Buckley, Schmidt 2001).

The widespread adoption of tillage methods in agricultural practice has the potential to increase soil microbial biomass and activity and the specific effects on fungal microorganisms are not fully known. Potential effects of soil tillage methods on increasing soil microbial biomass and activity and specific effects on fungal microorganisms are not fully known (Franzluebbers et al., 1995; Feng et al., 2003; Ng et al., 2012).

Soil degradation has now become an important environmental problem that limits agricultural sustainability throughout the world and reduces the production capacity of the land.

The soil degradation problem is the result of the deterioration of one or several of the physical, chemical and biological soil properties that constitute the soil quality parameters. The effects of different tillage methods on the physicochemical and biological properties of the soil are also quite different.

Among the tillage systems, conventional tillage is a tillage system in which most of the residue is buried in the soil, less than 15% of the residue is left on the soil surface after sowing, and heavy machine traffic is applied. Mouldboard plough is the main equipment of conventional tillage system. Conservation tillage method is a tillage system in which at least 30% of the soil surface is covered with plant residues after planting or in the critical erosion period (Köller, 2003).

In conventional systems, intensive and deep tilling of the soil results in numerous adverse effects on the physical, chemical and biological properties of the soil, and significant improvements in both environmental and soil quality parameters are obtained in conservative soil treatments and direct seeding systems. In this point, it is important to determine the level of soil cultivation and planting methods on the number of soil fungus in terms of high yield and healthy plant growth (Treonis et al., 2010; Wall et al., 2012; Zhang et al., 2015).

In the year 2016, approximately 1.2 million hectares of wheat are sown in the Southeastern Anatolia Region which corresponds to 15.79% of the total wheat cultivation area of Turkey and it is the third most important production area after Central and Western Anatolia (TÜİK, 2017a, b). In wheat cultivation, especially after the corn harvest, the conventional tillage practices are still widespread in the region.

In this study, it was aimed to determine the effect of conventional tillage, reduced tillage and direct seeding on the number of soil fungal microorganisms, which is a major effect during sowing and flag leaf penology in winter wheat growing.

MATERIALS AND METHODS

The study was carried out within the period of 2016-2017 wheat cultivation season at Dicle University Research Farm in Diyarbakır province located in Southerneast of Turkey (37°53'22'' latitude N, 40°16'38'' longitude E, 670 m above sea level). The study carried out on trial plots of 10 x 14 m, was planned in completely randomized parcel design with three replications. The study field has a clay (C) texture in 0-20 cm surface layer, consisting of 56.1% clay, 39.1% silt and 4.8% sand with pH of 7.3 and organic matter content of 1.0%. A semi-arid climate prevails in the study area. Three different tillage systems were applied in the study (Table 1) for wheat cultivation: conventional tillage (CT), reduced tillage (RT) and direct seeding (NT).

Table 1. The systems and the treatments

Systems	Treatments
Conventional Tillage (CT)	• Stubble chopper • Mouldboard plough • Disc harrow (2 times) • Scraper • Seeding
Reduced Tillage (RT)	• Cultivator • Disc harrow (2 times) • Scraper • Seeding
Direct Seeding (NT)	• Stubble cutting • Seeding

Commonly used bread wheat variety in the region was used as wheat seed. Irrigation of the wheat was carried out by sprinkler irrigation system. For the fertilizer requirement of wheat plants, 15-18 kg N da^{-1}, 8 kg P_2O_5 da^{-1} and 15-20 kg K_2O da^{-1} were given. No pesticides were used during the growing season. In the parcels that contains excessive amount of weeds, only the weeds were removed by hand and removed from the parcel.

Soil samples were obtained from two different periods; during the sowing and in the flag leaf phenological period of winter wheat. According to the simple random sampling method in

each parcel, 27 soil samples were taken for each period in three replicates.

Soil samples were collected from 5-20 cm depth of points determined according to simple random sampling method with the help of a shovel, and is placed in a polyethylene bag (Bora, Karaca, 1970; Saygılı et al., 2006). The obtained soil samples taken from rhizosphere layer were dried in room conditions and then passed through a 2 mm sieve to prepare for dilution technique. Before studying, a preliminary study performed to determine the amount of dilution suitable for determining the number of soil microbial populations in the dilution technique; 1/100000 and 1/1000000. In addition to Nutrient Agar (NA) medium used as a general feed for bacteria, Potato Dextrose Agar (PDA) medium was used for each sample in order to understand the effect of the medium in the study.

Before the analysis, Nutrient Agar (NA) and Potato Dextrose Agar (PDA) commercial formulations were prepared and autoclaved at 121°C for 20 minutes and sterilized under 1 atm pressure. Soil samples were dried and passed through a 2 mm sieve and soil particles under the sieve were used in the study. The soil sample obtained by sieving in this way was pounded into a sterile ceramic mortar and came to henna consistency. After weighing 10 g on a precision scale, was put in a 250 ml. volume of sterile Erlenmeyer. Sterile water was added to 10 g of soil sample in the sterile Erlenmeyer to complete the volume of 100 ml and it has been thoroughly mixed. The dilution rate here is 1/10. The soil-water suspension in the prepared Erlenmeyer was agitated for 5 minutes by means of a magnet stirrer. 1 ml of the soil-water suspension in the prepared Erlenmeyer is transferred to a test tube containing 9 ml. sterile water and mixed. 1ml of suspension in this test tube transferred to a test tube containing 9 ml sterile water and mixed again. This procedure was repeated in the same manner for 5 test tubes containing 9 ml of sterile water. The starting dilutions of the last two dilutions will be diluted to 1/100000 and 1/1000000.

100 µl (microliter) of the last two dilutions (1/100000 and 1/1000000) were pre-prepared with a micropipette using a sterile tip for each use, transferred to sterile petri dishes containing rested NA and PDA media, and spread through the sterile glass bag. Thus, for every soil sample, a total of 4 Petri dishes were inoculated to a Petri dish containing 1/100000 dilution 1 NA and 1 PDA media and to a Petri dish containing 1/10000 dilution 1 NA and 1 PDA media. The inoculated Petri dishes were wrapped with parafilm, incubated at 24±1°C, and counts of bacterial colonies were recorded every day for 10 days (Çınar, Biçici, 1991; Saygılı et al., 2006). All laboratory studies were carried out in a sterile sowing cabinet. In this respect, it is aimed to prevent contamination from air or other sources. The data obtained on the basis of ten days observations were recorded. The logarithmic transformation was performed to the obtained data because of a positive correlation between the variance of the groups and averages and statistical analysis was then performed by the SPSS program. The results were evaluated according to the statistical analysis of raw data.

RESULTS AND DISCUSSIONS

As a result of the study, the number of fungi was not statistically affected by soil tillage method, sampling time, medium and dilution. But the effect of sampling time*soil tillage interaction was found statistically significant ($p<0.05$).

On the other hand NT was significantly increased the number of fungi compared to CT and RT treatments (Figure 1). Frey et al. (1999) got the similar results that the fungal abundance was 10-60% higher in NT than in CT at all sites. Similar studies support the high number of fungi in conservation soil treatment applications (Minoshima et al., 2007; Van Capelle et al., 2012; Zhang et al., 2012).

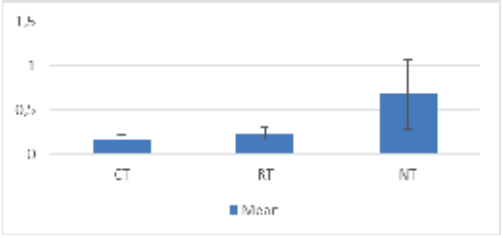

Figure 1. The means of fungi after tillage practises (F=1.037, df=2,192)

As is seen in Figure 2, there was a significant increase in the number of soil fungi from the time of sowing until the time of flag leaf in NT.

Among the methods, statistically different and high values were determined for the number of fungi in NT.

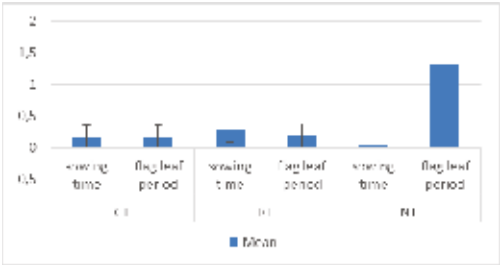

Figure 2. Effects of sampling time*soil tillage interaction on the number of fungi (F=4.249, df=2,192, P<0.05)

CONCLUSIONS

As we started to study, we expected the number of soil fungi to be statistically affected by all factors that we apply, but it didn't happen so. The number of soil fungi was significantly high in NT treatment than in RT and CT. But it is only statistically differed in sampling time*soil tillage interaction ($p<0.05$).

The abundance of soil fungi was related with soil moisture. Conservation tillage and direct seeding practices which keep soil moisture at ideal levels for fungal growing, leading to an increase in the number of fungi.

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