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Mini Review

An Adverse Bacterium Causes an Increase in Bean Yield

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Abstract

Rhizosphere bacteria play an important and important role in plant health and growth by helping plants withstand adverse effects such as soil salinity. Plastic film mulch is an important way to control soil properties and improve yields, especially in saline soils. However, whether and to what extent there is a relationship between these improvements and rhizosphere bacteria remains unclear. Here, field studies and greenhouse mesocosm experiments show that mulching plastic sheets with saline-alkaline soils enhances soybean growth outdoors. It was shown to grow better in unsterilized saline-alkali soil than in sterilized saline-alkali soil. By detecting changes in soil properties and analyzing high-throughput sequencing data, we found that the effect of film mulching effectively maintained soil water content, clearly reduced soil salinity, and reduced bacterial and fungal communities in the rhizosphere was found to reduce I have found it makes a big difference. Then the correlation analysis method was applied. Optimizing soil properties improved the survival conditions for soil microbes and promoted increased relative abundance of potentially beneficial microbes contributing to soybean growth. In addition, a taxonomy of potentially important rhizosphere microbial OTUs was identified. In conclusion, our study suggests an important influence of soil properties as a driver of changes in rhizosphere microbial communities, suggesting that rhizosphere bacteria in promoting plant performance in saline-alkaline soils under plastic sheet mulching shows the important role of it shows.

Keywords: Rhizosphere microbes, Plastic film mulching, Saline–alkali soil, Soybean

INTRODUCTION

Saline-alkali soils are widespread throughout the world and are considered one of the most important abiotic factors adversely affecting plant growth and production worldwide. It is estimated that more than 1 billion hectares of soil are threatened by salinization and alkalinisation, representing 7.5% of the world total. To make matters worse, the number is growing at a rate of over 10% each year. Extensive studies have shown that soil salinization and alkalinisation induce osmotic and ionic stress, disrupt nutrient cycling, and accelerate plant senescence, especially in agroecosystems. This leads to reduced yields and causes enormous economic losses each year **(Cole S A et al., 2017)**. However, the increased fertility of these soils after desalination highlights the usefulness of saline-alkaline soils. Improving salinity-alkaline soils to promote plant growth is therefore helpful for healthy and sustainable agricultural development **(Mason N M et al., 2017)**.

Plastic film mulching (PM) technology is a low-cost, easy-to-use and durable agricultural technique for increasing crop production that is widely used around the world, especially in Europe, Africa, Asia and the Americas. Over the past two decades, PM has increased global crop yields by an average of 25% to 42%, and the application of plastic film on agricultural land has increased significantly in recent years, reaching more than 1.5 million tons annually, especially in China. farmland. The PM content reaches 60-80%.

It has been widely reported that PM can increase crop yields. Although the potential of PM in conserving soil moisture modifying soil temperature and reducing weed pressure are often considered to be the main reasons for the crop harvests in previous studies, the influence of

PM on soil bacterium cannot be ignored Plant-associated bacterium , the second genome of plants, are crucial for plant health Root-derived microbiomes play an integral role in this complex community including a class of microbes that inhabit the narrow zone of roots known as the rhizosphere Mounting evidence signifies the importance of rhizosphere microorganisms in enhancing plant growth suppressing soil-borne disease and improving the capability to fight against abiotic stresses such as drought and salt However, the functional link between PM-induced shifts in rhizosphere microbial communities and crop yield remains essentially unknown **(Luo Y et al., 2017)**.

We hypothesized that soybean yield enhancement would be realized in both soil physicochemical properties and rhizosphere soil bacterium , with special key taxa representing the microbial group most responsive to PM and contributing to soybean yield enhancement. Through a field survey and a greenhouse microcosm experiment, we found that PM and soil bacterium were indeed important factors in promoting soybean growth in saline-alkali land. To further understand the role of rhizosphere bacterium in yield enhancement in saline–alkali soil under PM practices, we studied the soil physicochemical properties and rhizosphere soil bacterium, with a particular emphasis on the linking of them. We then identified 11 rhizosphere bacteria and 3 rhizosphere fungal OTUs reported in previous studies to have potential salt-tolerant and growth-promoting functions. The aim of this study was to (1) interpret the critical role of rhizosphere microorganisms in the process of PM-induced yield enhancement according to observations from field studies and greenhouse experiments, and (2) identify potential key specific taxonomies **(Wang H, 2017)**. To identify Rhizosphere bacteria and fungi associated with growth-promoting effects are linked. This study can provide a reference for the development of microbial agents **(Baležentis T et al., 2021)**.

MATERIAL AND METHODS

Root and soil samplings

In the fall and winter of 2020, field studies were conducted to collect soybean root samples associated with 12 cultivars growing in a natural saline-alkaline environment in Dongying, Shandong Province (37°46'N, 118°49'E). These soybean plants underwent two different treatments. C = chemical fertilizer, CF = chemical fertilizer with film mulch. Bulk soil samples were collected simultaneously according to the described procedure. That is, the 0-10 cm layer was removed and the 10-25 cm layer was collected **(Balsalobre-Lorente D, 2019)**. Shows selected properties of bulk soil samples. Moisture content was calculated as the dry weight of soil (105 °C for 12 hours) divided by the fresh soil weight. Conductivity (EC) was measured using an EC meter and K+ and Na+ levels were determined by flame photometry.

Rhizosphere soil samples were collected immediately after roots were returned to the laboratory in freshly preserved containers. Briefly, root samples were shaken to remove dirt and rinsed with sterile stroke saline. The supernatant of the mixture was then separated using a centrifuge at 10,000 xg for 10 min, and the sediment was defined as the rhizosphere bed **(Barbera AJ et al., 1990)**.

DISCUSSION

In this study, it was clarified from field surveys and greenhouse experiments that plastic film mulch and soil bacteria have growth-enhancing effects on soybeans under salt and alkali stress. We further explained the reasons for these differences in soybean growth promotion by analyzing the differences in rhizospheric bacterial and fungal communities between the two treatments and correlating changes in soil properties after plastic film mulching. Furthermore, we established taxonomy of potentially important rhizosphere microorganisms **(Adetutu MO et al., 2020)**.

The promotion of plant growth is closely related to complex and diverse changes in the rhizosphere microbial community and to the presence and activity of specific microbial communities. Thus, it is a potentially important rhizosphere microbial taxon **(Z Meng J, 2017)**. It is possible to understand the important role played by these special rhizosphere microbial taxa in the life of plants through integrating and analyzing the sequencing data of rhizosphere bacterium In our study, the significantly higher soybean yield in the CF treatment than in the C treatment observed from the field survey and significantly sturdier soybean growth in the S + F treatment than in the S + NF treatment observed from the greenhouse experiment are supported by previous studies showing that plastic film mulching could help plants grow better. The significantly better soybean growth in the US + F treatment than in the S + F treatment observed from the greenhouse experiment is consistent with previous findings indicating that the rhizosphere bacterium could help plants grow better **(Bhutta M et al., 2013)**. This is possibly because the environment of saline-alkali soil without plastic film mulching is detrimental to the survival and activity of soil bacterium, especially the functional rhizosphere microbial taxa. Furthermore, the results of variance partitioning analysis (VPA) and two-way ANOVA also revealed the separate and direct effects of plastic film mulching and soil bacterium on promoting the growth of soybeans under saline-alkali stress. After establishing the importance of soil bacteria for soybean growth, we further analyzed the high-throughput sequencing data of soil bacteria and fungi in the rhizosphere. The results showed that bacterial and fungal PCoA from the rhizosphere, but not Shannon, made a significant and positive contribution to soybean yield. Although no significant differences were found in Shannon of rhizobacteria and fungi between the two treatments, her PCoAs of rhizobacteria and fungi were clearly separated. These results suggested that the bacterial and fungal community structure (beta diversity) in the rhizosphere was altered by plastic film mulching, and these alterations could affect soybean yield, which is supported by previous findings. In addition, effect size linear discriminant analysis (LEfSe) results indicated that these changes were primarily reflected in significant differences in taxa and abundances of soybean rhizosphere microorganisms enriched between the two treatments. . Specifically, 95 bacterial OTUs and 65 fungal OTUs were significantly differentiated between the two treatments. Several of these OTUs that could promote soybean growth, namely potentially important microbial taxa in the H. rhizosphere, were detected at significantly higher frequencies (|log2-fold change in OTUs|>1, $p< 0.05$), which was 100% enriched with CF treatment compared with C treatment, and soybean yield increased significantly and positively correlated with these OTUs. These results further suggest a link between increased soybean yield in saline-alkaline environments and increased relative abundance of potentially important bacterial and fungal taxa in the rhizosphere.

CONCLUSIONS

In summary, the application of plastic film mulch to saline-alkaline fields changed the soil properties, resulting in a decrease in soil salinity and maintenance of soil moisture. Improving soil properties as a driver altered the structure of rhizosphere bacterial and fungal communities, which was predicted to be the main factor affecting yield. These changes mainly reflected taxonomic differences and abundance of bacteria and fungi abundant in soybean rhizosphere soil. Potentially important rhizosphere microorganisms were detected significantly more frequently and 100% enriched in CF treatment compared with C treatment, resulting in increased soybean yield. However, a potential significant rhizosphere microbial growth-promoting effect remains theoretical in our study. Our subsequent studies focused primarily on screening and validation of functional microbes, highlighting interactions between soybean and rhizosphere bacteria via their association with rhizosphere metabolites.

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