Intercropping of Faba Bean and wheat enhances soil microbial interactions and N_2-fixing symbiosis establishment

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INTRODUCTION

Intercropping is the simultaneous production of more than one crop species in the same field. One of the most commonly used intercropping mixtures is the legume / non-legume (usually cereals) combination. This cultural practice has often been shown to provide advantages in comparison with sole crops. Higher grain protein content in the cereal at harvest has also generally been recorded. These yield and grain quality enhancements are generally assumed to be linked to the complementary use, in time and space, of N sources by the different components of the intercrop.

Although it is now well admitted that the plant cover composition induces large modifications in the genetic and functional characteristics of soil microbial communities, the impacts of the intercropping cultural practice on the functional diversity of nitrogen-fixing bacteria (rhizobia) have been poorly studied. In addition the effects of rhizobia associated with the legume on the cereal growth (PGPR effects) is largely unknown.

The aim of this work is to study the impacts of the intercropping cultural practice, i.e. the association between *Vicia faba* L. and *Triticum turgidum* L. subsp. *durum* (Desf.), on the functional diversity of nitrogen-fixing bacteria (rhizobia) and to evaluate and compare the effects of these rhizobial strains on the cereal growth (PGPR effects).

MATERIALS AND METHODS

A study was conducted in glasshouse conditions with 2 treatments (*Vicia faba* L. (F) and *Vicia faba* L. + *Triticum turgidum* L. subsp. Durum (F+W)) in pots filled with a P deficient soil collected from a field located near Marrakech (Morocco). After 3 months culture, the rhizobial strains were isolated from nodules of faba bean plants according to Vincent (1970). They were purified and kept at -80°C for further analysis. We evaluated their P solubilizing capacity in solid media using two nitrogen forms NH_4Cl and KNO_3 and the $Ca_3(PO_4)_2$ inorganic P source (TCP medium). The ability of the bacterial isolates to synthesize siderophores is detected by the appearance of an orange color around the bacterial colony using Chrome Azurol S (CAS) medium. The production of the extracellular lipase enzyme from the bacteria was detected by the presence of crystals around the bacterial colonies. The effects of the rhizobial strains on the wheat growth were tested in axenic conditions using Gibson tubes.

RESULTS

We screened a collection of 70 rhizobial strains isolated from the treatment (F + B) and the treatment (F). Sixteen rhizobial strains from (F+W) (50%) and 13 rhizobial strains from (F) (42%) are able to solubilize P with the NH_4Cl nitrogen source. Four rhizobial strains from (F+W) (12.5%) and 6 rhizobial strains from (F) (19.3%) %) are able to solubilize P with the KNO_3 nitrogen source(Figure 1).

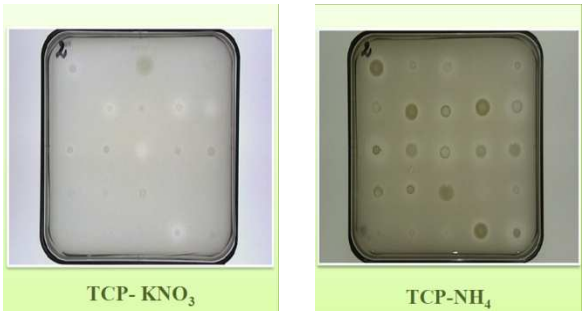

Figure 1: Solubilization halots detected with some rhizobial isolates using the TCP medium with 2 different N sources (NH_4Cl and KNO_3)

The siderophore production activity was detected by one rhizobial strain isolated from (F+W) and 6 rhizobial strains from (F). Sixteen rhizobial strain from (F+W) (50%) and 15 rhizobial strains from (F) (48%) can produce the extracellular lipase enzyme.

The effect of bacterial isolates on wheat growth was tested with 22 strains from treatment (F + W) and 17 others strains from treatment (F).

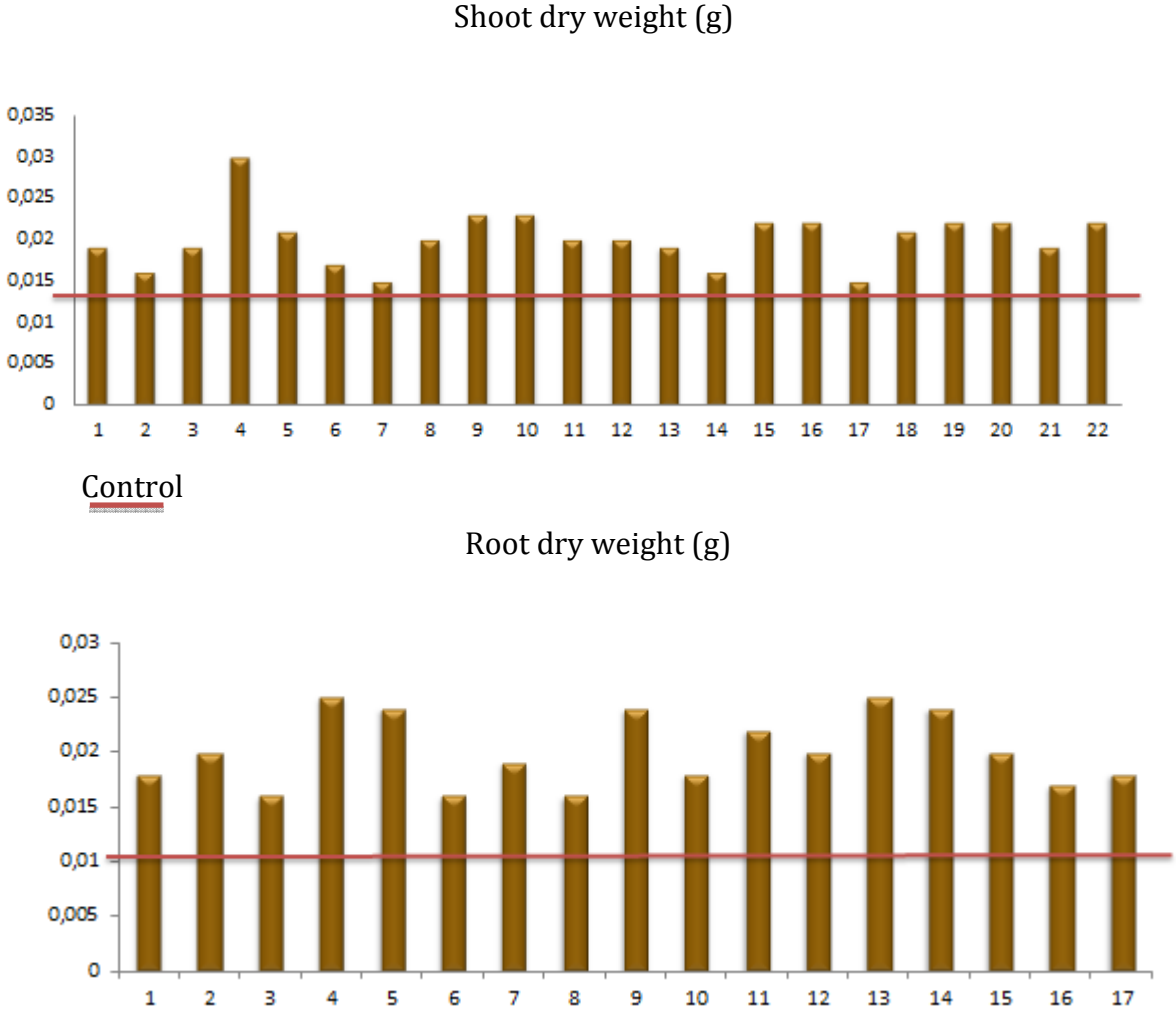

Figure 2: Effect of rhizobial strains on wheat growth

For all the parameters (Shoot biomass, Root biomass, Total biomass), only one strain from the treatment (F + B) and 2 strains from the treatment (F) had no significant effect on the wheat growth. The wheat seedling shoot biomass was significantly enhanced by 15 strains from the treatment (F + B) and 15 from the treatment (F). This promoting effect was also observed with 10 strains (F + B) and 6 (F) for the root biomass.

The wheat seedling total biomass was significantly higher than that measured in the control treatment for 16 strains (F + B) and 15 strains (F).

CONCLUSION

The results show that most of the rhizobial strains isolated from Faba bean displayed PGPR effects on the wheat growth in axenic conditions. These results showed that the benefits of the intercropping cultural practice are not limited to a trophic effect (enhancement of N plant nutrition) but could result from microbial interactions that can act directly on the wheat growth (PGPR effect) or indirectly through a N_2-fixing symbiosis establishment.

Acknowlegments

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