Microbial Communities in the Rhizosphere of Pulse Crops under Semiarid Growing Conditions

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Introduction

Rhizosphere is the soil zone adjacent to plant roots which is an area with intense biological and biochemical activities. The microbial communities in rhizosphere influence plant growth by interacting with plant roots, therefore, affecting soil chemical properties. All the activities make the rhizosphere the most dynamic environment in the soil, which is key for plant health by the contributions of microorganisms to nutrients availability from soil to plant. Understanding rhizosphere microbial communities is important to develop production systems with improved resource use efficiency. Therefore, this study was to determine bacterial and fungal populations in the rhizosphere of chickpea, field pea and lentil with or without JumpStart inoculation under semiarid growing conditions.

Materials and Methods

The experiment was conducted at Semiarid Prairie Agricultural Research Centre, Swift Current, SK, in 2006 and 2007.

- **Soil Sampling**

Metal core tubes (15.3 × 120 cm) were set up in the field using a hydraulic system device. Pulse crop seeds inoculated with JumpStart (with active component of *Penicillium bilaii,* a natural soil occurring fungus) were sown in metal tubes. At flower and maturity stages of the crop, soil cores were obtained and cut into segments at intervals of 10 cm for the top 60 cm and 20 cm for the bottom 60 cm. Rhizosphere soil samples were taken from each soil segment, and the soil samples were bulked into top (0-20 cm) and bottom (20-100cm) soil samples.

- **Determination of Bacterial and Fugal Population**

a) Dilution Plating

Dilution plating was used for determining bacterial and fungal populations, where 3 g of soil sample was put into 27 ml 0.1% Tween 80 to make 10 fold serial dilutions. From the preliminary experiments, the dilution series for bacteria were 10^{-6}, 10^{-5}, 10^{-4}, and 10^{-3} and for fungi were 10^{-5}, 10^{-4}, 10^{-3}, and 10^{-2}. Rose Bengal Potato Dextrose Agar (RBA) media were for fungi while Tryptic Soy Agar (TSA) was used for bacteria. Incubating RBA plates at 22°C for 120 hrs and TSA plates at 28°C for 72 hrs.

b) Colony Counting

For fungi population, counting was conducted when it had 15 to 150 colonies/ plate, whereas bacterial counts were done when there were 25 and 250 colonies/ plate.

Results and Discussion

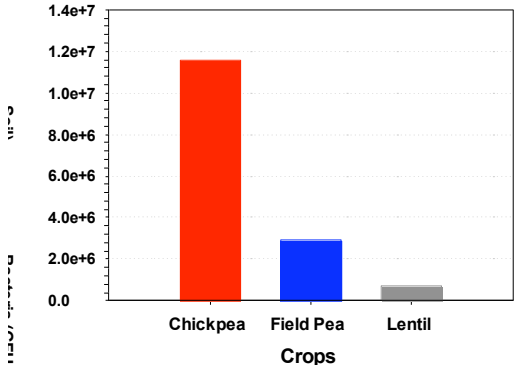

Fig 1. Bacterial populations for 3 pulses

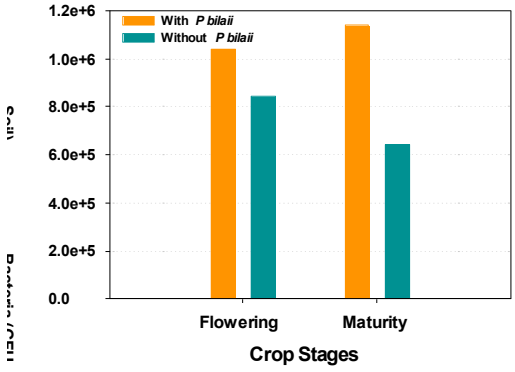

Fig 2. Bacterial populations for 3 pulses with/ without JumpStart at two crop stages

Among three pulse crops tested, chickpea had higher bacteria counts in the rhizosphere than field pea and lentil (Fig.1). This difference was consistent during flowering and maturity stages of the crop (data not shown). All 3 pulse crops inoculated with *P. bilaii* had higher bacterial counts than those without inoculation of *P. bilaii* regardless of crop stage (Fig. 2). There was a tendency that bacterial populations decreased from flowering to maturity without *P. bilaii*, but it increased when *P. bilaii* was applied.

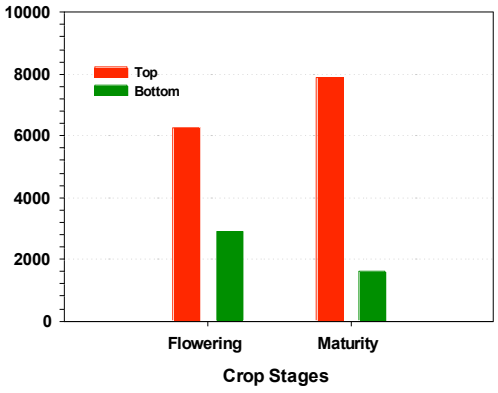

Fig 3. Fungi populations in the top and bottom soils at two crop stages

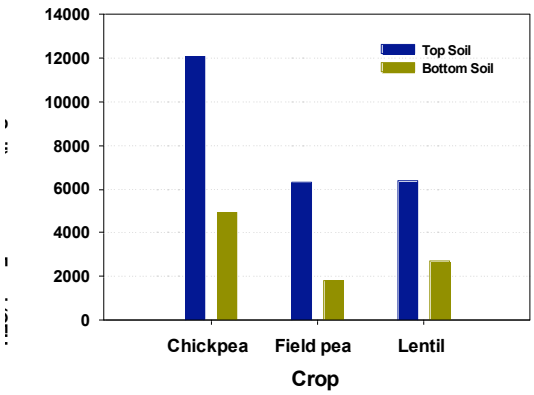

Fig 4. Fungi populations in the top and bottom soils for 3 pulse crops

Top soils always had more fungi than bottom soils at both flowering and maturity stages with the highest counts of fungi being in the top soil at maturity stage (Fig. 3). This difference was

consistent for all three pulse crops. However, chickpea always had the highest counts of fungi in both the top and bottom soils through the growing stages (Fig. 4).

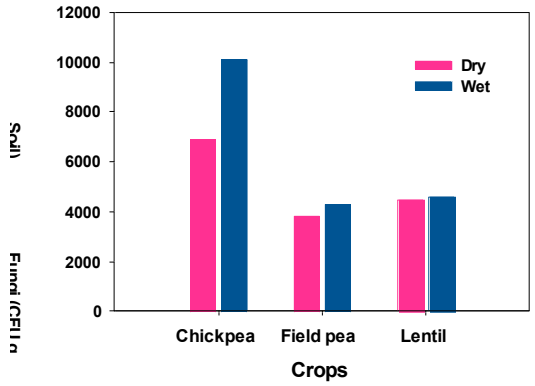

Fig 5. Fungi populations for 3 pulse crops grown under dry and wet conditions

Chickpea had higher fungi populations under wet conditions compared to dry conditions, whereas the growing conditions did not affect fungi populations for field pea or lentil (Fig. 5)

Conclusions

Rhizosphere microbial communities, especially bacteria and fungi, play fundamental roles in nutrients cycling, plant growth and plant health. The present study determined some key factors influencing microbial population, diversity and activity. The abundance of rhizosphere microorganisms was affected by various environmental and plant factors including nutrients, moisture, plant species and plant age. Based on two years of field experiments, we concluded that crop species had significant effects on bacterial and fungal populations in the rhizosphere (P<0.05) with chickpea having the highest microorganism counts. Pulse crops inoculated with *P. bilaii* had higher bacterial populations than non-inoculated pulses measured at the same growth stage. Bacterial and fungal populations were generally higher in the top soil (0-20 cm) layer compared to bottom (20-100 cm) soils, with soil water having a marginal effect.

Acknowledgements

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