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The Dynamics of Actinomycetes and Fluorescent Pseudomonads in Wheat Rhizoplane and Rhizosphere*

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Abstract

Actinomycetes constituted a higher proportion of soil and rhizosphere microflora than fluorescent pseudomonads which rapidly declined during root development particularly in the rhizoplane. Treatment with fertilizers containing high nitrogen levels significantly reduced the percentages of fluorescent pseudomonads.

Introduction

The study of the indigenous soil bacteria within the plant rhizosphere and their possible role in the protection of a plant against soil-borne diseases (Neal et al., 1970) has received much less attention, for example, than studies concerning the effects and survival of introduced bacteria in root-free soil or in the rhizosphere. It is necessary, therefore, to locate those bacterial groups which may be abundant in the rhizoplane and rhizosphere and then to study their function with reference to prevention and reduction of plant infection by deleterious microorganisms. However, one factor which is frequently overlooked is the constantly changing state of the rhizosphere which automatically influences its bacterial composition.

This study follows the total numbers and percentages of actinomycetes and fluorescent pseudomonads in the rhizoplane and rhizosphere during the growth of Canadian spring wheat. Emphasis is placed on the growth stages which follow the seedling stage. The effect of fertilization on the root-free and rhizosphere bacteria has also been taken into consideration.

*Reviewed

Methods

The experiments were conducted in loamy sand (pH 6.2) with a moisture content kept at 15%. Canadian spring wheat, line C–R_5B, was sampled between the 4th and 9th week of growth. Growth chamber conditions, details of the soil and plant sampling and preparation methods as well as the methods used for counting the total numbers of bacteria (colony forming units), actinomycetes and fluorescent pseudomonads have been described by Miller et al., (1990).

Two experiments involving the effect of fertilizer on fluorescent pseudomands were carried out. Root-free soil was fertilized with a mixed mineral fertilizer (60/40 $NH_4^+ - N/NO_3^- - N$: 140 mg N/kg soil) and examined over a 9 week period. In another experiment both root-free soil and soil to be used for rhizosphere studies were treated with two levels of nitrogen (35 mg and 175 mg N/kg soil). Soils were examined between the 20th and 67th day.

Results and Conclusions

The total number of bacteria increased in both the rhizoplane and the rhizosphere of wheat between the 4th and 9th week (Table 1); flowering mostly occurred after the 50th day. The numbers of actinomycetes were relatively stable and represented a higher percentage of the total bacterial microflora (decreased from 8% to 4% in the rhizosphere and from 4% to 0.4% in the rhizoplane) than the fluorescent pseudomonads which declined rapidly to less than 0.2% in the rhizosphere and to less than 0.01% in the rhizoplane.

Table 1. Bacterial counts (cfuX10^6) in the rhizosphere[1] and rhizoplane[2] of wheat during 4th to 9th week of growth.

Week	4	5	6	7	8	9
Total Bacteria[3]	121	144	187	207	463	425
Actinomycetes[1]	9.27	9.38	11.0	11.5	11.6	17.1
Fl. Pseudomonads[1]	—	1.73	0.8	0.81	0.54	0.55
Total Bacteria[2]	832	524	836	771	2010	2170
Actinomycetes[2]	—	17.9	9.16	7.93	8.73	—
Fl. Pseudomonads[2]	—	0.61	0.05	0.04	0.06	0.08

The decreased stimulation of fluorescent pseudomonads recorded in this experiment may explain the highly variable results often found for this bacterial group in biological control experiments. It may be more worthwhile, therefore, to study the activity of larger bacterial groups in the rhizosphere, e.g. actinomycetes.

Fertilization had little influence on the total number of bacteria in root-free soil but increases could be found in the rhizosphere. The addition of a mineral fertilizer

(140 mg N/kg soil) resulted in a significant (40%) decrease in the percentage of fluorescent pseudomonads. The higher level of added nitrogen (175 mg N/kg soil) also caused a significant decrease in the percentage of the fluorescent pseudomonads in the root-free soil as compared to the low level (35 mg N/kg soil). This decrease was highly significant in the plant rhizosphere. These results show that fertilization can have a marked effect on the rhizosphere bacteria under controlled climatic conditions. Fertilization effects should be taken into consideration in field experiments.

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