Fungistatic Activity of Bacteria of the Genus Azospirillum

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Bacteria of the genus Azospirillum belong to the group of associative nitrogen-fixing microorganisms. The nitrogen fixed by Azospirilla is easily accessible to plants /RED'KINA, 1989/. Besides the ability to fix atmospheric nitrogen, Azospirilla have another important property; they are capable of forming substances of a phytohormonal nature /TIEN et al., 1979/. This property allows them to be considered as stimulators of plant growth. Azospirilla positively influence the plant, not only by providing it with biological nitrogen, but also as a result of their phytohormonal activity.

Studies have shown that the display of these properties by Azospirilla in association with plants is regulated by the plant. Under some conditions Azospirillum only acted as a stimulator of plant growth, and under others, only as a fixator of atmospheric nitrogen /RED'KINA, 1988/. Besides these two properties, these bacteria have been shown to depress the growth of phytopathogenic fungi and bacteria.

The ability of different strains of Azospirillum to form substances of an antibiotic nature was tested by growing them on nutrient medium M_2 with starch. The supernatant liquid of the cultures was tested for the formation of antibiotic substances by diffusion in HOTTINGER agar with test microbes /gram-negative and gram-positive bacteria, yeast and fungi/.

The results obtained are presented in Table 1. As can be seen from the data, the ability of Azospirilla to form substances of an antibiotic nature is different for different strains.

The fungistatic activity of Azospirilla was tested on a wide spectrum of phytopathogenic fungi. The influence of different Azospirilla strains on phytopathogenic fungal growth is presented in Table 2. As can be seen from the data in the table, the Azospirillum strains tested had different fungistatic activities. Strain 94-3, isolated from grey forest soil, and epiphytic strains, isolated from germinating oats and barley seeds, had the most pronounced fungistatic effect.

Rhizopus microsporus and Rhizopus cochnii turned out to be the most sensitive to the antibiotics produced by all strains of Azospirillum. The growth of Penicillium brevicum compostum was depressed by all the strains of Azospirillum tested. Some species of Aspergillus were the most susceptible to antibiotic compounds. Some strains of Azospirillum were capable of excreting very strong antibiotic substances, depressing the growth of such

Table 2

Fungistatic effect of azospirilla on soil fungi

Fungus used as test object	Strains of Azospirilla									
	Barley	fescue grass	94-3	winter wheat	15 P	brome grass	341	Oat	DP-1	Krasno-darsky
Aspergillus versicolor	-	-	-	±	±	-	-	-		
A. flavus	±	+	+	-	-	-	-	+		+
A. cyclopium	-	-	+	+	+	-	-	-		
A. ruber	+	+	+	+	+	+	+	+		
A. candidus	+	+	+	+	-	-	+	+		
A. sulphureus	+	+	+	+	+	+	+	+		
A. allilaceus	+	+	-	-	-	-	-	-		
A. chevalieri	+	+	+	+	+	+	+	+		
A. flavipes	+	+	+	+	+	+	+	+		
A. amylovorus	+	+	+	+	+	+	+	+		
Rhizopus microsporus 2018	+	+	+	-	-	-	-	-		
Rh. cohnii 1218	+	+	+	-	-	-	-	-		
Mucor fragilis			+						+	
Penicillium brevicum compostum	+	+	+	+	+	+	+	+		+
P. digitatum 1256	+	+	+	-	-	-	-	+		
Alternaria	+	+	+	+	+	+	+	+	+	+
Fusarium moniliforme		+	+							+
Fusarium oxysporum		+	±			±		±	+	+
Thielaviopsis basicola			+						+	+

Symbols: /-/ no fungistatic effect; /±/ fungistatic effect is minimal; /+/ depression of fungal growth

Table 1

Ability of Azospirilla to form substances of an antibiotic nature

Test objects	Strains of Azospirilla isolated from			
	Oats	Barley seeds	Rice roots	Soil strain 341
Staphylococcus aureus	23	26	13	16
Escherichia coli	-	19	-	-
Pseudomonas aeruginosa	-	-	-	-
Candida albicans	-	34	24	30
Aspergillus niger	-	33	40	13

The figures indicate the zone /in mm/ where the growth of the test objects was depressed = no antibacterial effect.

strong fungal phytopathogens as Fusarium oxysporum, Fusarium moniliforme and Thielaviopsis basicola.

The fungistatic activity of Azospirilla was also observed in the plant--fungus-Azospirillum system. The presence of many species of phytopathogenic fungi /Helminthosporium, Fusarium, Penicillium, Aspergillus, Rhizopus, Alternaria and others/ on the seeds of different cultivars of rice was shown in work by IMOLEHIN /1934/. Azospirillum has been found to be part of the epiphytic microflora of rice, wheat, barley seeds, and the seeds of cereal grasses and to have a protective function during seed germination /RED'KINA and KALININSKAYA, 1981/. During the current studies two batches of seeds were grown. One batch of seeds lacked epiphytic Azospirilla and when these seeds were growing, strong fungal infection was observed. Seeds of another batch had a large number of epiphytic Azospirilla, and here no fungal infection of the seedlings was observed.

In experiments with rice seedlings infected by the fungus Alternaria, the protective function of Azospirilla was shown by inoculating the plants with Azospirilla.

Table 3

Influence of cotton plant growth of Azospirillum against a background of fungal infection in pot experiments

Strains of Azospirillum	Percentage of healthy plants	
	Thielaviopsis basicola	Fusarium oxysporum
94-3, isolated from turf-podzolic soil in the Moscow region	40	-
DP-1, isolated from turf-podzolic soil under winter wheat in the Moscow region	100	80
Krasnodarsky, isolated from chernozem soil under rice, in the Krasnodarsky region	100	80

In pot experiments on cotton plants the function of protection from the phytopathogenic fungi Thielaviopsis basicola, the pathogen of cotton plant root rot, and Fusarium oxysporum, the pathogen of cotton plant wilt, was studied. Infected seedlings of cotton plants were inoculated with various strains of Azospirillum. The effectiveness of Azospirilla in preventing fungal infection is shown in Table 3.

As can be seen from the data in Table 3, the effectiveness of the tested strains differs; thus, strain DP-1 and the Krasnodarsky strain provided cotton plants with 100% protection from the pathogen causing root rot and 80% protection from cotton plant wilt.

The fungistatic activity of bacteria in the genus Azospirillum is a property capable of playing an important role in the relations of this group of bacteria with higher plants.

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