

Effect of Azospirillum Inoculation on the Yield of Maize

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To ensure high maize yields, use is made of large amounts of nitrogen fertilizers. One way of reducing these high rates, and of protecting the environment against pollution, is to increase the relative share of biologically fixed nitrogen.

The present investigation is aimed at establishing the effect of inoculation with *Azospirillum brasilense* spp. 1774 in the HA-708 hybrid considered promising under Bulgarian conditions.

Materials and methods

The investigation was carried out for a period of two years on leached cinnamonic forest soil, maize being the predecessor, at three rates of nitrogen dressing /0, 100 and 200 kg per ha/ with 55 000 plants per ha under a deficiency-free water regime.

The maize seeds were inoculated with *Azospirillum brasilense* spp. 1774 /titre 9.2×10^5 per ml/ obtained from the USA collection, manifesting the highest nitrogen-fixation activity among the 6 strains compared in a preliminary investigation in a biological sample under laboratory conditions.

The following phases were analysed: tassel blossoming, grain formation, milky ripeness, and post-grain harvesting.

The following indices were determined: nitrogen-fixation activity /acetylene reduction assay conducted with excised roots/, total nitrogen content /Kjeldahl/, accumulation of absolute dry biomass, and grain yield, as well as the quantity of microorganisms /by the plate dilution method/.

Results and discussion

The data in Table 1 show that the nitrogen-fixation activity in all variants increased in the course of plant development, with a maximum in the phase of grain formation, when the values, in nM ethylene, were several times higher compared to those in the phase of tassel blossoming later, in the phase of milky ripeness, the values of nM ethylene declined, but remained higher than those in the phase of tassel blossoming.

The Azospirillum-treated variants manifested higher activity in all phases, compared to untreated ones, except for the variant with 200 kg of nitrogen applied.

It should also be pointed out that there was a high background of nitrogen-fixation activity in the control variants, probably due to a spontaneous infection of the plants.

Table 1

Nitrogen-fixation activity in various phases of development of maize

Variants	Nitrogen-fixation activity /nM ethylene . 24 ⁻¹ sample ⁻¹ /		
	Tassel blc:ssang	Grain formation	Milky ripeness
N ₀ P ₁₅₀	4359	9496	4955
N ₀ P ₁₅₀ inoculated	4436	22824	20206
N ₁₀₀ P ₁₅₀	1820	13387	3684
N ₁₀₀ P ₁₅₀ inoculated	2135	27041	13101
N ₂₀₀ P ₁₅₀	2545	24699	13387
N ₂₀₀ P ₁₅₀ inoculated	1945	19445	5785

The data given in the table, however, show that increases in the rates of dressing, both in control and treated variants, had a positive effect on the nitrogen-fixation activity up to certain limits, up to 100 kg of nitrogen per ha. A further increase in the nitrogen dressing rate exerts a depressing effect on this process.

The quantity of microorganisms in the groups investigated /Table 2/ in the rhizosphere of maize showed a positive inoculation effect. Almost all the inoculated variants possessed a great number of aerobic nitrogen-fixing microorganisms. The quantity of microorganisms growing on soil agar manifested the same trend, suggesting the more efficient usage of root irradiations caused by inoculation. The quantity of bacteria of the Azospirillum species also increased in variants subjected to inoculation, substantiating the suggestion that a relatively stable associative connection is built up between maize and the strain tested.

As regards the total nitrogen content in plants and its dependence on nitrogen-fixation activity various results and opinions have been published. Our data do not provide grounds for any concrete conclusions to be drawn, either. However, the data show a considerable increase in the total nitrogen content in the cobs during the phases of grain formation and milky ripeness, as well as in the grain itself after harvesting, for variants given 100 kg of nitrogen per ha. This increase amounts to 50, 15 and 69%, respectively, in favour of the treated variants.

Table 3 shows the final effect of inoculation of maize hybrid HA-708 on the end products, dry biomass and grain yield. The data presented show

Table 2
Dynamics of the microorganisms investigated

Variants	Aerobic soil agar microorganisms	Aerobic N ₂ fixing bacteria 10 ⁶ .g.soil ⁻¹	<u>Azospirillum</u> spp.
<u>At tassel blossoming</u>			
N ₀ P ₁₅₀	1.88	1.89	1.37
N ₀ P ₁₅₀ inoculated	3.19	2.85	3.57
N ₁₅₀ P ₁₅₀	1.11	1.86	1.60
N ₁₀₀ P ₁₅₀ inoculated	2.15	2.45	3.13
N ₂₀₀ P ₁₅₀	0.87	1.01	2.13
N ₂₀₀ P ₁₅₀ inoculated	2.03	1.83	1.80
<u>At grain formation</u>			
N ₀ P ₁₅₀	8.20	6.56	0.23
N ₀ P ₁₅₀ inoculated	14.49	13.52	1.26
N ₁₀₀ P ₁₅₀	5.81	5.60	0.56
N ₁₀₀ P ₁₅₀ inoculated	6.91	8.00	1.00
N ₂₀₀ P ₁₅₀	10.01	8.07	0.88
N ₂₀₀ P ₁₅₀ inoculated	10.67	9.24	1.30
<u>At milky ripeness</u>			
N ₀ P ₁₅₀	6.73	6.09	1.12
N ₀ P ₁₅₀ inoculated	13.51	13.12	8.23
N ₁₀₀ P ₁₅₀	6.35	8.17	3.76
N ₁₀₀ P ₁₅₀ inoculated	10.22	13.45	5.43
N ₂₀₀ P ₁₅₀	9.74	12.53	5.28
N ₂₀₀ P ₁₅₀ inoculated	8.97	8.47	5.57

an increase in the amounts of these products after Azospirillum brasilense spp. 1774 treatment, the highest value being obtained with an average rate of dressing, i.e. 100 kg of nitrogen per ha. The average increase in the grain yield was 6% for the two years.

Table 3
Dry biomass and maize grain yield

Variants	<u>Biomass</u> kg/ha	Grain yield
N ₀ P ₁₅₀	1161	706
N ₀ P ₁₅₀ inoculated	1252	782
% difference	+ 8	+ 2
N ₁₀₀ P ₁₅₀	1551	868
N ₁₀₀ P ₁₅₀ inoculated	1727	916
% difference	+ 11	+ 6
N ₂₀₀ P ₁₅₀	1765	910
N ₂₀₀ P ₁₅₀ inoculated	1889	948
% difference	+ 7	+ 4

Conclusions

The results of the two-year trial carried out show that the inoculation of the maize hybrid HA-708 makes it possible to limit the amount of nitrogen fertilizer applied in growing this highly important crop. However, further investigations are required if more concrete conclusions are to be drawn and recommendations made.