

**YIELD OF TOMATOES AND PEPPERS UNDER THE INFLUENCE
OF EXOMETABOLITES OF *NOCARDIA VACCINII* IMV B-7405,
ACINETOBACTER CALCOACETICUS IMV B-7241
AND *RHODOCOCCUS ERYTHROPOLIS* IMV AC-5017**

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The ability of rhizobacteria to synthesize phytohormones has long been considered a major factor in promoting plant growth. There have been many reports of significant improvements in growth and increased yields of agronomically important crops in response to inoculation by bacteria capable of synthesizing certain phytohormones. The ability to simultaneously synthesize surfactants and plant hormones provides the basis for developing a waste-free technology for the complex microbial preparations with various biological properties. Also we can conduct researches for integrating such technology into the practice of agricultural production. In previous study we have tested the effect of culture broth *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017 on the growth and development of tomatoes and barley [1]. For barley the increase of yield on 33.3-83.3% compared to control (treatment with water) has been observed. At the same time for the most of tomatoes treatment options the weight of fruits was less than control, although the number of fruits was higher. Obtained result we associate to the fact that the culture broth of the strains contained too high concentration of plant hormones, which did not show optimal effect on tomatoes.

In connection with the above, the aim of this work is to study the effect of various concentrations of phytohormones synthesized by *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017 on the growth and yield of tomatoes and peppers.

Bacteria were cultivated using a synthetic medium. Refined sunflower oil, technical glycerol was used as the carbon source. Substrate concentration was 2% (v/v). Phytohormonal extracts were obtained from the supernatant of culture broth after the extraction of surfactants. Gibberellin and auxin extracts were obtained from the supernatant of the culture broth by three times extraction with ethyl acetate (ratio 1:1) at pH 2.5, and cytokinin extracts were obtained by three times extraction with butanol (ratio 1:1) at pH 8.0. The extracts were evaporated to dryness under vacuum and redissolved in 80% ethanol.

Greenhouse experiments were carried out in greenhouses from May to September 2018. Before planting in the soil, the root system of tomato and pepper seedlings was kept for two hours in diluted extracts of phytohormones and water

(control). In each variant there were six plants. During the experiment, the number of fruits and their weight were analyzed.

In the present research, the tomatoes root system was treated with the solutions of phytohormones and not with a culture broth, since the main aim of the experiment was to find an effective concentration of phytohormones for the stimulating effect on plants. In the future, this will help to determine the optimal dilution for preparations based on the culture broth *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017. The choice of dilutions of phytohormonal extracts was based on the results of a previous study published in [1], according to which the increase of the tomato yield was shown only under treatment with IMV Ac-5017 strain. This is due to the fact that the culture broth *R. erythropolis* IMV Ac-5017 contained up to 25 times lower concentration of phytohormones than *N. vaccinii* IMV B-7405 and *A. calcoaceticus* IMV B-7241. Accordingly, for strains IMV B-7405 and IMV B-7241, it is necessary to find a concentration of phytohormones that will be at the level of the effective concentration of the strain IMV Ac-5017.

The experiments have shown that the treatment of tomato seedling of Hrusha variety with exometabolites of *N. vaccinii* IMV B-7405 and *A. calcoaceticus* IMV B-7241 strains before planting into the soil stimulated the growth of seedlings, increased the number of fruits and accelerated their maturation (Table 1).

Table 1 – Indicators of tomatoes yield under the treatment with phytohormonal extracts, obtained after cultivating *N. vaccinii* IMV B-7405 and *A. calcoaceticus* IMV B-7241 on refined oil.

Treatment	Dilution of phytohormonal extract	No. of fruits	Average fruit weight (g)	Increase of total weight compared to control, %
Control (water)	–	17	25.2	–
<i>N. vaccinii</i> IMV B-7405	1:5000	19	25.3	11.3
	1:10000	25	28.2	63.9
<i>A. calcoaceticus</i> IMV B-7241	1:3000	41	25.7	145.0
	1:5000	28	25.0	62.8

These data demonstrate that the number of fruits on plants treated with phytohormonal extracts (regardless of their dilution degree) was higher than after treatment with water. It should be noted that in most experimental variants the average fruit weight almost did not differ from control (25.0–25.7 g). Slightly higher was the average fruit weight (28.2 g) on plants treated with 10000 times diluted phytohormonal extract of *N. vaccinii* IMV B-7405. Depending on the degree of dilution of the phytohormonal extracts, the total weight of fruits collected from the treated plants was on 11.3–145.0% higher than in the control variant. We can conclude that the optimal dilution for *N. vaccinii* IMV B-7405 was 1:10000 (+63.9%), and for *A. calcoaceticus* IMV B-7241 it was 1:3000 (+145.0%), because they showed the best stimulation of the tomatoes growth.

Rotunda peppers, which, as well as tomatoes, belong to the Solanaceae family, were chosen as the second test culture. The results of the experiment demonstrate that in all studied variants of treatment the number of fruits or their weight were increased compared to control, and also the flowering and ripening of the fruits accelerated (Table 2).

Table 2 – The effect of phytohormonal extracts obtained after cultivating *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017 on refined oil, on yield of peppers.

Treatment	Dilution of phytohormonal extract	No. of fruits	Average fruit weight (g)	Increase of total weight compared to control, %
Control (water)	–	8	32.25	–
<i>R. erythropolis</i> IMV Ac-5017	1:1000	10	28.8	+11.6
	1:2000	8	32.9	+2.0
<i>N. vaccinii</i> IMV B-7405	1:10000	10	45.7	+77.1
<i>A. calcoaceticus</i> IMV B-7241	1:3000	12	33.83	+57.3

The data in the table show that the treatment with strains *N. vaccinii* IMV B-7405 in dilution of 1:10000 and *A. calcoaceticus* IMV B-7241 in dilution of 1:3000 had the best stimulation of the growth and development of peppers, both by the weight and the number. For strain IMV B-7405 the number of fruits exceeded the control by 25.0%, and the total weight by 77.1%, as for the strain IMV B-7241 these figures increased by 50.0% and 57.3% respectively.

Such results coincide with those obtained in the experiment with tomatoes, indicating that such concentration of phytohormones is optimal for stimulating plant growth. As for the *R. erythropolis* IMV Ac-5017 strain, we couldn't determine which of the dilutions is more optimal for treatment, since the total weight of the fruits in both variants practically coincides with that obtained under the treatment with water. These results require further discussion.

The results obtained in this work give us grounds for the development of preparations based on the culture broth of *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017, since we were able to find the optimal concentration of phytohormones for the manifestation of stimulating effect on tomatoes and peppers. The results obtained earlier and the results presented in this article are the basis for the development of a waste-free technology using *N. vaccinii* IMV B-7405, *A. calcoaceticus* IMV B-7241 and *R. erythropolis* IMV Ac-5017. Such technology will allow us to develop complex microbial preparations with various biological properties in a single process. Thus, in the preparation of surfactants, the precipitated cells can be used to purify water from oil; obtained culture supernatant – for further isolation of surfactants with anti-adhesive and antimicrobial properties

(including against phytopathogenic bacteria). And the aqueous phase, which remains after the extraction of surfactants and contains phytohormones of auxin, cytokinin and gibberellin nature, will be used in agriculture to stimulate plant growth.

Literature

1. Havrylkina D.V., Leonova N.O., Pirog T.P. The influence of exometabolites *Nocardia vaccinii* IMV B-7405, *Acinetobacter calcoaceticus* IMV B-7241 and *Rhodococcus erythropolis* IMV Ac-5017 on yields of tomatoes and barley // J. Agric. Environ. 2019. V. 1. №9. P. 1–8.