The formation of productivity and stress resistance of leguminous plants in association with endophytic bacteria, which complemented the deficient properties of plant-host genotype

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Key message. The strong and weak properties of peas and beans cultivars were identified in field experiments. The best productivity of inoculated plants was due to the resistance to biotic and abiotic stress induced by endophytic bacteria.

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Endophytic bacteria are the normal microbiome of a health plant, affecting its physiological status. Plant growth promoting and exhibiting antagonistic activity to phytopathogens nonrhizobial endophytic bacteria of root nodules are of particular interest (Garipova et al., 2017a), since they are assumed to coexist in neutral relations with rhizobia (Garipova et al., 2017b), can take part in biocontrol reactions to prevent the plant from diseases and maintain its symbiotic activity. However, it is reported that inoculation of plants with useful strains of endophytic bacteria may have not significant effect on plant productivity in the field (Lally et al., 2017).

The purpose of the work was the investigation of the influence of inoculation of peas and beans cultivars with selected strains of endophytic bacteria on plant productivity in contrast agroclimatic conditions of South Urals.

Research methods included the production crops and small-scale field experiments of 2003–2018. The plant growth characteristics, nodule-forming activity, root rots and leaf diseases, crop structure elements were tested.

Results. In field experiment the limiting properties of each studied pea and bean cultivars were identified. The pea cultivar Chishminsky 95 had a high symbiotic activity, but was susceptible to root rot and characterized by moderate degree of drought tolerance. Bean cultivar Ufimskaya was rather-ripe, resistant to drought and to diseases. Bean cultivar Zolotistaya was adaptive to drought, but later ripens and was susceptible to diseases. Bean cultivar Elsa belonged to the intensive type cultivar: it formed a high yield under favorable environmental conditions but low yield under drought, it was resistant to leaf lesions, but susceptible to root rot.

Seed inoculation of pea cultivar Chishminsky 95 with a combination of selected strains *Serratia* sp. Ent16 + *R. leguminosarum* Rh16 resulted in increase averaged 16% over three years compared to uninoculated control. This was accompanied by decrease in the incidence of root rot from moderate degree to low degree and maintaining high symbiotic activity. The positive effect of this combination on pea seed yield was established in production crops – the yield increase was 13 % in compare of uninoculated control. In response to the inoculation of bean plants with the best selected strains of endophytic bacteria, the different cultivars showed an individual strategy for improving productivity. Inoculated plants of Ufimskaya cultivar increased the yield of inoculated plants in compare of control due to the improvement of size and branching of the roots and enlarged biomass. Inoculated plants of Zolotistaya cultivar accelerated the ripening. The inoculated Elsa plants characterized by the intensified branching of shoots and increased the number of seeds per plant. The best couples of symbionts for beans were: Ufimskaya cultivar – *R. leguminosarum* SG13 strain, Zolotistaya cultivar – *B. subtilis* SG12 + *R. leguminosarum* SG13 strains, Elsa cultivar – *R. leguminosarum* 2630 (model strain). Analysis of statistically insignificant and ineffective inoculation results showed that such cases have occurred if bacteria were used: a) in favorable environmental conditions, b) with an adaptive to limited conditions plant genotype, c) when the biological was applied in supra-optimal doses. The optimal doses of bacteria were different in interaction with specific plant genotype.

Conclusion: Endophytic bacteria exert a multidirectional effect on the growth and development of plants, supplementing those properties that increase its resistance to diseases and adaptation to environmental conditions. An individual selection of endophytic bacteria strains is required for specific plant cultivars.

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