

Competition for Nodulation of *Pisum sativum* L. Between Strains of *Rhizobium leguminosarum* by viceae

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Competition for nodulation of host plants among rhizobial strains seems to be one of the most important criterion for selection of the strains as inoculants /DOWLING and BROUGHTON, 1986/. The aim of this work was to evaluate nodulation, dinitrogen fixation and competition abilities of several *Rhizobium* strains applied as single- or double-strain inocula or co-inoculated with soil samples.

Materials and methods

Rhizobium cultures. *R. leguminosarum* by viceae Hup+ strain 128C30 /NELSON and SALMINEN, 1982/ was obtained from R.S. Smith. The NITRAGIN Co. Milwaukee, Wis., U.S.A. The Hup- strain D253 /SKRADLETA et al., 1987a/ and strain D1 /preliminary Hup+/ were obtained from Hana Marecková, Research Institute of Crop Production, Prague-Ruzyně, Czechoslovakia.

Table 1

Number of *Rhizobium* cells applied per seedling as single- and double-strain inocula or co-inoculated with the soil

128C30	D253	D1	Ratio	Soil	Gamma irradiated soil /25kG Y/
9.0x10 ⁹	-	-	-	-	-
-	7.5x10 ⁹	-	-	-	-
-	-	1.3x10 ¹⁰	-	-	-
4.5x10 ⁹	3.8x10 ⁹	-	1.2:1	-	-
4.5x10 ⁹	-	6.3x10 ⁹	1:1.4	-	-
-	3.8x10 ⁹	6.3x10 ⁹	1:1.7	-	-
-	-	-	-	7 g	-
7.0x10 ⁷	-	-	-	7 g	-
7.0x10 ⁷	-	-	-	-	7 g

Plants. Two-d-old seedlings of the pea cv Bohatyr were inoculated with cultures of the appropriate strain, with double-strain mixtures or co-inoculated with air-dried grey-brown podzolic soil samples from experimental fields of the Research Institute of Crop Production /Table 1/. The plants were grown under controlled environmental growth conditions in perlite supplied with nutrient solution /SKRDLETA et al., 1980/ containing $76 \text{ mg L}^{-1} \text{ Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$.

Assays. Acetylene reduction in air was determined on nodulated roots as previously described /SKRADLETA et al., 1987a/. Dry root nodules, roots and tops were analyzed for combined nitrogen by the automated Dumas method /the CHN 600 analyzer, IECO Co., Saint Joseph, Mi., U.S.A./.

Results and discussion

Effect of single- and double-strain inocula

The specific nodulation of host plants was significantly influenced by the inoculum type. The largest nodule dry mass was produced by the plants inoculated with D253 and with a mixture D253+D1, whereas the inoculation with 128C30 and its mixtures with the two former strains resulted in a remarkably lower nodulation. In contrast, total acetylene reduction per nodulated root and specific C_2H_2 reduction by nodule tissue were much higher when 128C30 was present in the inocula. The content of nodule dry mass /Fig. 1/ confirmed our previous findings /SKRDLETA et al., 1987b, 1988/ that the Hup+ strain 128C30 induces nitrogen-rich root nodules (>8.5%; Nnr+ symbiotic phenotype/, while the Hup- strain D253 induces nodules containing 3.4 to 2.6% N only /Nnr-/. In the present experiments D1 also induced root nodules with a high N content /8.4 to 8.0%. However, nitrogen-rich nodules were also formed when 128C30+D1 and 128C30+D253 double-strain inocula were applied. On the contrary, the D253+D1 strain mixture induced nitrogen-poor nodules with a nitrogen content similar to that resulting from the D253 single-strain inoculation. These findings suggest that 128C30 is competitively superior to D253 and D1, and that its application in the double-strain inocula blocks the host plant nodulation by the latter strains almost completely. In a similar way, D253 probably prevents nodulation by D1.

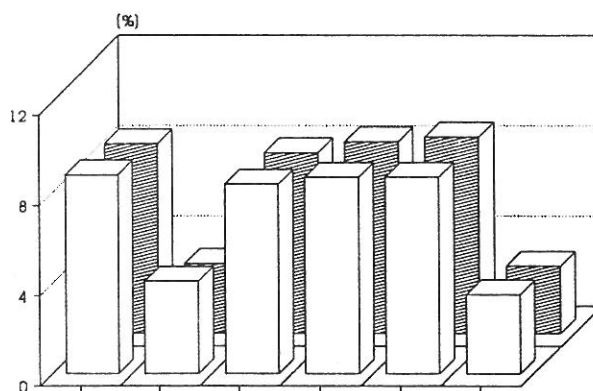


Fig. 1
Nitrogen content of nodule tissue

Inoculation with the single- and double-strain inocula did not significantly affect plant dry biomass yield. Nevertheless, the inoculation with 128C30 and its mixtures always resulted in a higher plant dry weight. The same holds also for the nitrogen yield per plant.

Rhizobium - Soil co-inoculation

On the basis of the preceding experiments, 128C30 was applied together with soil samples. Similarly to previous results, the co-inoculation with 128C30 significantly decreased specific nodulation, increased specific, C_2H_2 -reducing nitrogenase activity of nodule tissue /Fig. 2/, increased the N content of the nodule dry mass /Fig. 3/ and slightly increased plant biomass yield. It is evident that 128C30 competitively blocked the nodulation by an indigenous soil Rhizobium population. This ability was manifested irrespective of the high nodule formation induced by the soil Rhizobium itself.

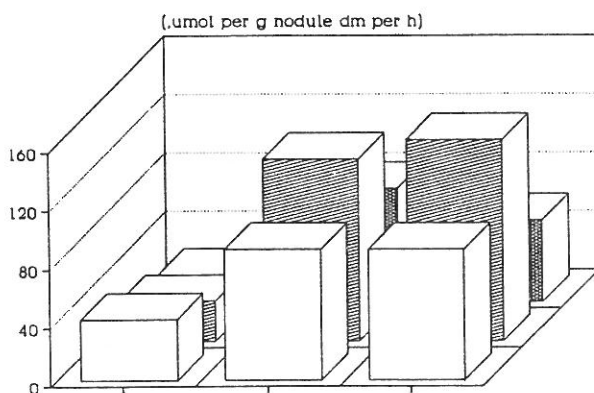


Fig. 2
Specific acetylene reduction
LSD /27d/ = 15.8; LSD /41d/ = 33.6; LSD /55d/ = 22.9; P < 0.05

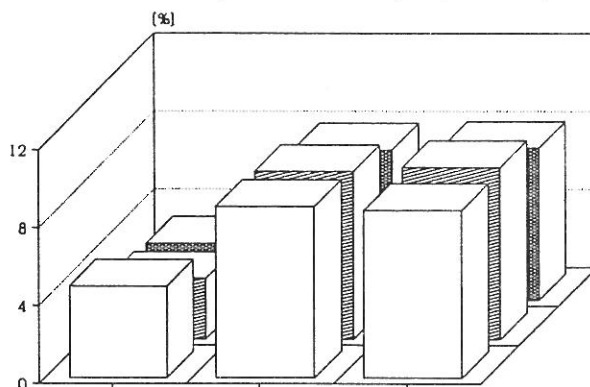


Fig. 3
Nitrogen content of nodule tissue
LSD /27d/ = 0.2; LSD /41d/ = 1.0; LSD /55d/ = 0.4; P < 0.05

References

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