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PLANT NUTRITION AND ITS PROSPECTS

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PLANT NUTRITION AND QUALITY OF SOYBEAN

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Introduction

Soybean (*Glycine max* [L.] Merr.) is by far the most important oilseed crop in the world (Wilcox, 2004) grown on about 92 million hectares world-wide at present. While soybean production is mainly taking place in the Americas and in Asia, European countries are the leading importers of whole soybeans and soy meal. During the past two decades, however, soybean production was successfully initiated in several regions of Central and South Europe. As the European oilseed production from oilseed rape, sunflower, linseed, olive and other oil crops is well established and highly productive, the focus in European soybean production is in the high seed protein content rather than in its oil.

Generally, soybean seed oil content is around 200 g/kg (dry matter basis), whereas protein content is in the range between 350 and 450 g/kg. As soybean is a legume crop, symbiotic dinitrogen fixation has a huge impact on soybean quality and on seed protein content in particular. This contribution presents a summary of different experiments investigating the influence of different plant nutrition parameters on soybean seed protein content. Apart from the soybean genotype, biological dinitrogen fixation, mineral nitrogen or sulphur fertilization, and the growing environment will be presented with respect to their impact on seed protein content and other quality parameters.

Materials and Methods

Different experiments were carried out in the soybean growing regions of Austria, i.e. Lower Austria, Vienna, Burgenland, and Styria from 1996 to 2006. Several sets of soybean genotypes and breeding lines of maturity groups 0 to 000 were used in particular experiments. Soybean seeds were usually inoculated with the commercial *Bradyrhizobium japonicum* (Kirchner) Jordan preparations Nodular-G (Serbios, Badia Polesine, Italy) or Radicin No. 7 (Jost, Iserlohn, Germany) during sowing. Experiments were grown in single row plots in two replications using generalized lattice designs. Soybean seed samples were harvested at full maturity, and seed protein content was determined by Fourier transform near-infrared reflectance spectroscopy (Bruker MATRIX-I spectrophotometer, Bruker, Ettlingen, Germany) and expressed in g/kg dry matter. Raw data from individual experiments/plots were initially analysed using the respective design information and appropriate statistical model, whereas combined analyses across experiments/ environments were carried out on an entry (genotype) mean basis.

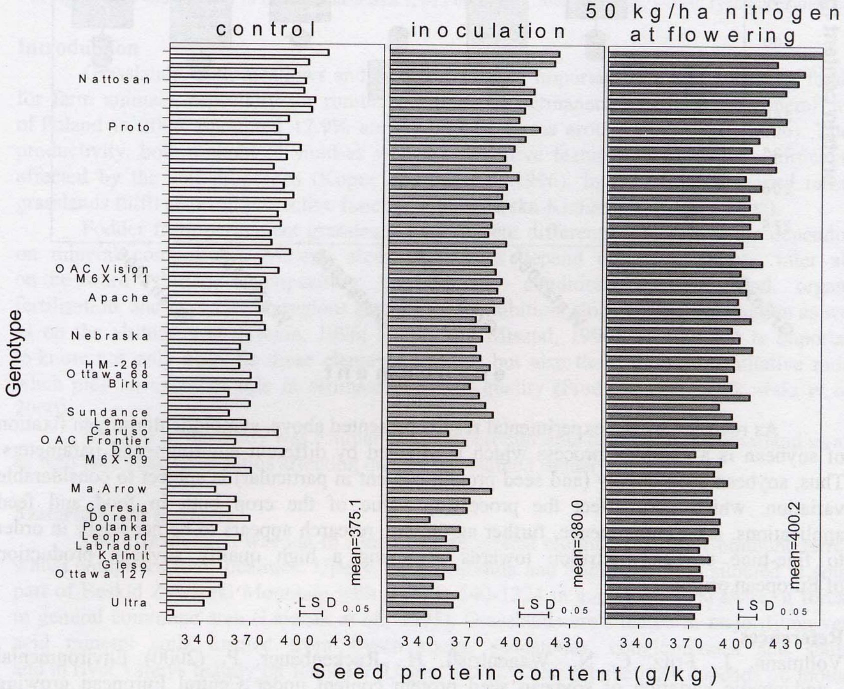
Results and Discussion

As shown in Fig. 1, inoculation of soybean with rhizobia or nitrogen fertilization at the flowering stage do have a clear influence on seed protein content of different soybean cultivars, whereas the genotype by treatment interaction was less important; oil content was not affected by inoculation, but clearly reduced after nitrogen fertilization (for more details see Vollmann *et al.*, 2000).

In another set of experiments (Raasdorf, 1998; 1999; 2000), seed protein content was increased over control by 60 kg/ha nitrogen or 30 kg/ha nitrogen plus 35 kg/ha sulphur, while soybean trypsin inhibitor activity was reduced by both treatments as compared to controls (for more details see Vollmann *et al.*, 2003).

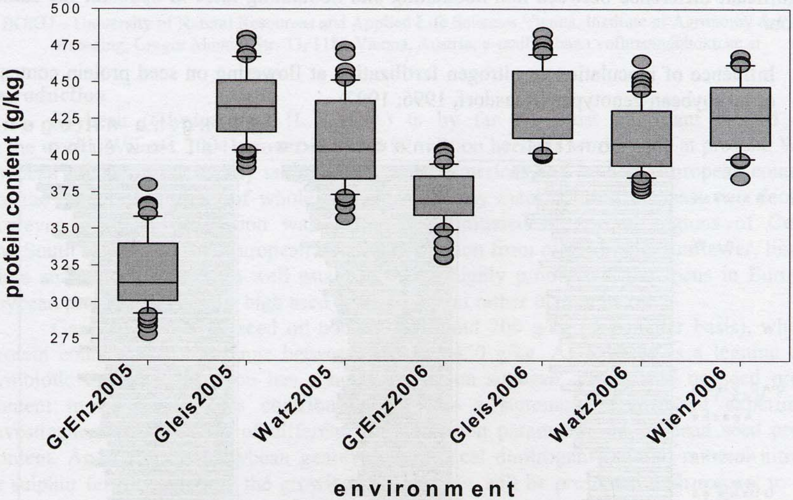
In an experiment using a soybean population segregating for the ability of nodulation, seed protein content was in the range from 330 to 360 g/kg for non-nodulating lines and between 350 and 415 g/kg for nodulating lines in the 2005 season, whereas there was no significant difference between non-nodulating and nodulating lines in 2006 for the same location.

Fig. 1 Influence of inoculation or nitrogen fertilization at flowering on seed protein content of 60 soybean genotypes (Raasdorf, 1996; 1997)



Another set of 50 genotypes including breeding lines selected for high seed protein content was grown in seven different environments (Gross Enzersdorf, Gleisdorf, Watzelsdorf, Vienna, 2005 and 2006 seasons). Huge differences in seed protein content were found, as illustrated in Figure 2. In low protein environments such as GrEnz2005 (Gross Enzersdorf 2005) or GrEnz2006 (Gross Enzersdorf 2006), seed protein content was in the range from 275 to 375 and 325 to 400 g/kg; in contrast, protein contents in high protein environments such as Gleisdorf or Watzelsdorf (organic farming environment with a long history of soybean cultivation in crop rotation) of up to 475 g/kg were achieved for particular genotypes. In the low protein environments GrEnz2005 and GrEnz2006, no or only a low degree of nodulation was observed, whereas soil Nmin mineral nitrogen levels were 245 and 101 kg N per ha in mid May, respectively. Nmin nitrogen was clearly lower in the other environments and therefore did not inhibit nodulation; subsequently, a much better late season nitrogen supply through biological dinitrogen fixation was achieved which greatly contributed to increased seed protein content of the soybean crop.

Fig. 2 Variation of soybean seed protein content for a set of 50 genotypes grown across 7 environments



As revealed by the experimental results presented above, symbiotic dinitrogen fixation of soybean is a complex process which is affected by different environmental parameters. Thus, soybean seed quality (and seed protein content in particular) is subject to considerable variation, which may affect the processing value of the crop both in food and feed applications. As a consequence, further agronomic research appears to be necessary in order to fine-tune soybean nutrition towards achieving a high quality soybean production of European origin.

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