Agronomy Research **15**(4), 1725–1732, 2017
https://doi.org/10.15159/AR.17.026

The yield, height and content of protein of field peas (*Pisum sativum* L.) in Estonian agro-climatic conditions

M. Olle

Estonian Crop Research Institute, Department of Plant Breeding, J. Aamissepa 1, EE48309 Jogeva alevik, Estonia
Correspondence: margit.olle@etki.ee

Abstract. *Pisum sativum* L. is important protein crop in the world. The purpose of this investigation was to see whether pea varieties differ in their yield, height and content of protein. Another aim was to select the best varieties suitable for production. Field experiments with different varieties of peas ('Bruno', 'Capella', 'Clara' and 'Vitra') were carried out at the Estonian Crop Research Institute in 2014 and in 2015. Yields (t ha^{-1}) in 2014 and 2015 did not differ much, while yield from variety 'Bruno' was very different between years 2014 and 2015 and was much higher in 2015. The most suitable height of field peas is in a range of 60...100 cm, because the plants with such a height are most effectively suppressing weeds. It can be concluded that varieties with suitable height in our investigation were: 'Bruno', 'Capella' and 'Clara'. Variety 'Vitra' was too high, is lodging easily and is therefore hard to harvest. Crude protein content (% in dry matter) was lowest in 'Clara'; all other varieties had a higher content of protein, within much the same range. Based on the results of present investigation it can be concluded that out of those four varieties the most suitable varieties for production are 'Bruno' and 'Capella'. Choice of the right variety for pea cultivation is very important, but depends on the local agro-climatic conditions. As in Baltic – Nordic countries and in north of America the agro-climatic conditions are more or less similar the results are useful for those countries.

Key words: height, field pea, protein, variety, yield.

INTRODUCTION

Field peas are also known as smooth peas or specifically green and yellow cotyledon dry peas (Dahl et al., 2012). It is an herbaceous annual crop in the *Fabaceae* (formerly *Leguminosae*) family. The Mediterranean basin and the Near East are the places from where pea crop originates. Nowadays it is widely grown for its seedpod. Pea is an important human food crop (Olle et al., 2015). Dry pea production worldwide in 2014 was 11.2 Metric Tons (www.statpub.com) and in the same year pea was grown on over 7.2 million hectares worldwide (www.statpub.com). The most widely grown legume crops in the European Union are dry peas (Monti et al., 1991) and overall in Europe (Brežna et al., 2006).

Eating legumes could potentially let people live longer (Patterson et al., 2009). An increased consumption of legumes in the EU is highly desirable taking into account the high nutritional value and the beneficial health effects of legumes. Legumes contain high

level of protein and adequate proportions of carbohydrates and oil making them valuable as food (Rodino et al., 2009).

The habitat quality, weather conditions during the growing season and the yielding ability of available cultivars are those factors, which influence mainly seed and biomass yields, which could vary much (Jeuffroy & Ney, 1997; Poggio et al., 2005).

Cultivar, location and environmental/growth conditions affect pulse seed quality and composition. The large variation of pea seed quality between individual samples within a year suggests a large impact of the combination of environmental conditions, agronomic practice and genetic factors. Wide ranges of protein content were noted between samples of the same variety. This suggested that, within a variety, crude protein content could be used as an indicator of a general 'environmental' effect (Wang & Daun, 2004). The protein content of field peas may vary as followed: 15.8–32.1% (Blixt, 1978), 20.5–22.1% (Jabeen et al., 1988), 21.9–34.4% (Bastianelli et al., 1998), 18.3–31% (Hedley, 2001), 20.6–27.3% (Burstin et al., 2007), 24–32.4% (Gabriel et al., 2008a; 2008b), 15.8–32.1% (Pratap, 2011), 21.4–23.9% (Saastamoinen et al., 2013). Harmankaya et al. (2010) found that the protein content for the nineteen pea genotypes ranged from 21.13 to 27.05%, with a mean of 23.89% and stated that these differences in protein content were due to a combination of genetic and environmental factors.

The purpose of this investigation was to see whether pea varieties differ in their yield, height and content of protein and to find suitable varieties for production in Estonian agro-climatic conditions.

MATERIALS AND METHODS

A field experiment with varieties of field pea (*Pisum sativum* L.) was carried out at the Estonian Crop Research Institute in 2014 and 2015. The varieties were: 'Bruno', 'Capella', 'Clara' and 'Vitra'. 'Capella' and 'Clara' are Swedish varieties, and 'Bruno' and 'Vitra' – Latvian varieties. In our experiment the leafy variety was 'Vitra' and semi-leafless varieties were 'Bruno', 'Capella' and 'Clara'. A completely randomized experiment design was used in 4 replications. Plot size was 10 m^2. Soil conditions in 2014 were followed: Soil humus content was 3.15% and pH was 5.76. Soil type was soddy-calcareous podzolic soil in Estonian system (Astover, 2005). The preceding crop was winter rye. Soil conditions in 2015 were followed: Soil humus content was 3.46% and pH was 6.29. Soil type was calcaric cambisol soil in Estonian system (Astover, 2005). The preceding crop was barley. Conventional cropping system was used with ploughing in autumn 2013 (for 2014 cultivation) and in 2014 (for 2015 cultivation), and cultivation twice before sowing both years. Seeds were sown on 28 April 2014, and on 1 May 2015 at a rate of 120 seeds per m^2 for all varieties and a depth of 4 cm. Plant spacing was 12.5 × 6.7 cm.

Fertilization was done with Yara Mila 7–12–25 (300 kg ha^{-1}) both years. In 2014 and 2015 weeds were controlled by Activus 330 (pendimethalin 330 g L^{-1}) EC 1.5 L ha^{-1} + Basagran 480 (bentazon 480 g L^{-1}) 1.5 L ha^{-1}, on 21 May 2014, and on 5 June 2015. No control measures against insects and diseases were applied. Disease damage on peas pods, pod spot (*Ascoshyta pisi*), pulses rust (*Uromices* ssp.) was assessed at the plant development stage 71–79 (assessment method described in Strauß et al., 1994). In 2014 followed diseases were present: Pod spot on 'Bruno' and 'Vitra' was at a very low level, and on 'Clara' and 'Capella' at a low level. Pulses rust was absent on 'Clara', 'Capella'

and ‘Mehis’, at a very low level on ‘Bruno’ and at a low level on ‘Vitra’. In 2015 followed diseases were present: Pod spot on ‘Bruno’, ‘Clara’ and ‘Capella’ was at a very low level, and on ‘Vitra’ at a low level. Pulses rust was either absent or on very low level on all varieties.

The weather during 2014 is shown in Fig. 1. In 2014 it was characterized by a cold spring. The temperature at the end of June was 3–4 °C lower than normal, but July was near average with a mean temperature around 18 °C. Precipitation exceeded the average in June although it was quite dry in July; nevertheless plants grew well. The weather during 2015 is shown in Fig. 2. At ECRI 2015 year weather has been very different from average (cold spring and cold summer) with some decades of too much rain and some decades of a little rain.

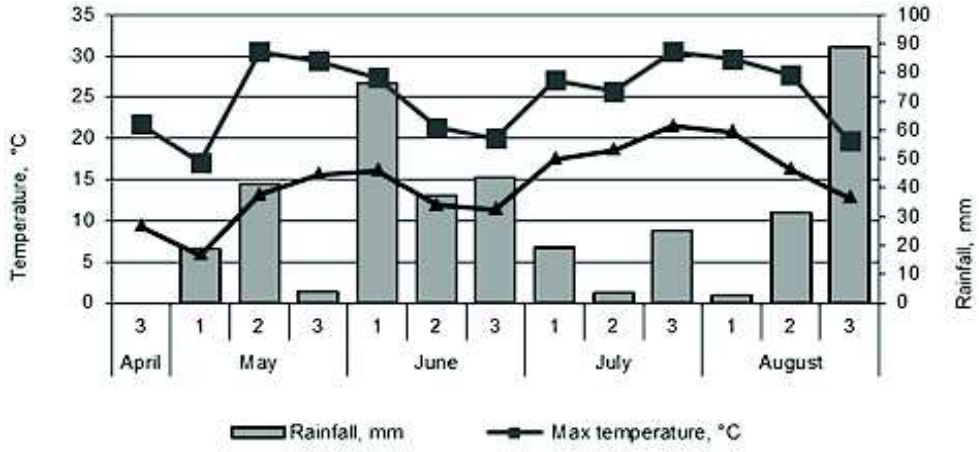

Figure 1. Weather conditions of field pea vegetation period in 2014 according to Jogeva Meteorological Station.

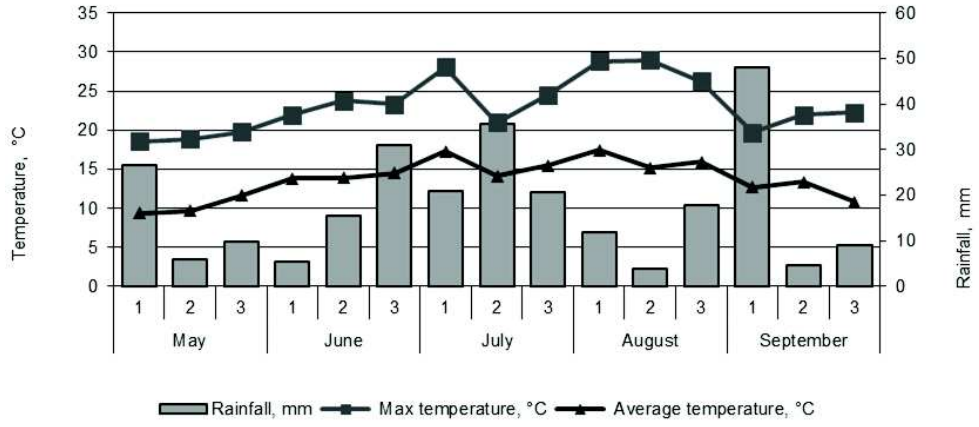

Figure 2. Weather conditions of field pea vegetation period in 2015 according to Jogeva Meteorological Station.

Peas were harvested between 6–12 August in 2014 and between 20–28 August in 2015, dried and the yield data (determined at moisture content of 14–15%) recorded for each plot and finally calculated for t ha^{-1}. Some days before harvest on both years the height of plants were measured for 10 plants (with average look in the plot) in every plot. Samples were analysed for their content of protein. Determination of protein content was by the Kjeldahl method (EVS-EN-ISO 10520:200). Analyses of variance were carried out on the data obtained using the programme *Excel*. Signs used: *** $p < 0.001$; ** $p = 0.001–0.01$; * $p = 0.01–0.05$; NS – not significant, $p > 0.05$. On figures, on columns are marked bars, which are the bars of standard deviations.

RESULTS

Yields (t ha^{-1}) in 2014 and 2015 did not differ much, while yield from variety 'Bruno' was very different between years (2014, 2015) and was much higher in 2015. In 2014 there was a tendency that the highest yield was obtained in 'Clara' and 'Vitra' (3.3 t ha^{-1}), followed by 'Capella' (2.8 t ha^{-1}) and 'Bruno' (2.6 t ha^{-1}), but differences were not statistically different (Fig. 3). In 2015 the highest yield was obtained by variety 'Bruno' (4.6 t ha^{-1}), followed by 'Vitra' (4 t ha^{-1}), 'Clara' (3.3 t ha^{-1}) and being lowest in 'Capella' (2.9 t ha^{-1}).

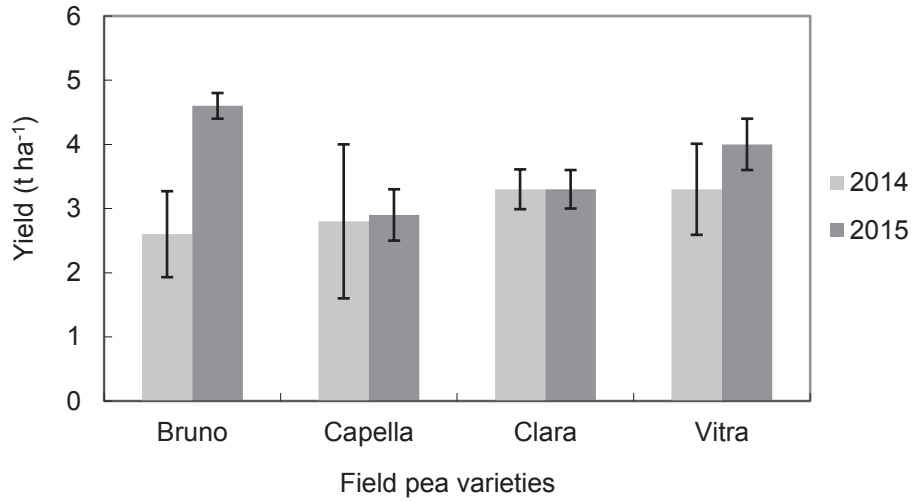

Figure 3. Dry grain yield (t ha^{-1}) of different field pea varieties (p in 2014 NS and in 2015***).

Crude protein content (% in dry matter) was lowest in 'Clara'; all other varieties had a higher content of protein, within much the same range. In 2014 crude protein content was the lowest in 'Clara' (23.6% in dry matter) and higher in all other varieties, although not ranging much from each other (26.9–27.9% in dry matter) (Fig. 4). In 2015 crude protein content was the lowest in 'Clara' (23.9% in dry matter) and higher in all other varieties. Crude protein content in all other varieties was ranging a little from each other (24.6–26.9% in dry matter).

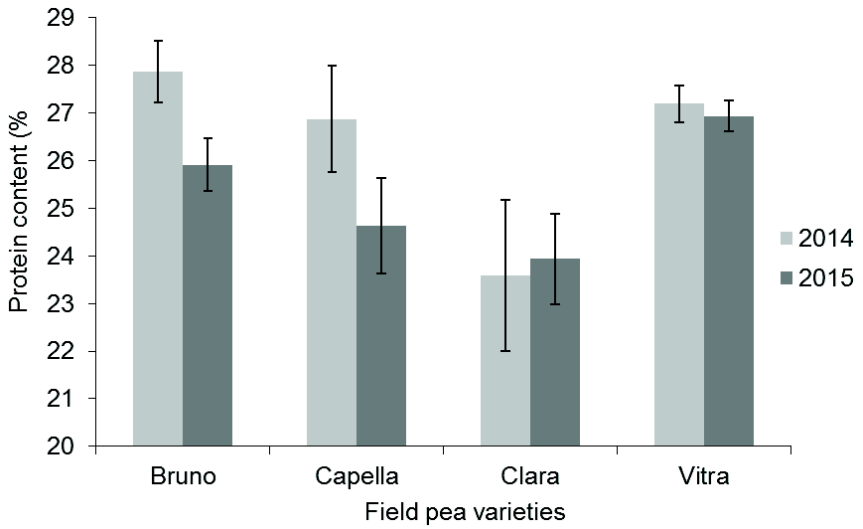

Figure 4. Average protein content (% in dry matter) of different field pea varieties (p in 2014*** and in 2015***).

The most suitable height of field peas is in a range of 60–100 cm, because the plants with such a height are most effectively suppressing weeds and they also are lodging not so easily (Olle, 2015). Results in 2014 and 2015 are showing that varieties with suitable height in our investigation were: 'Bruno', 'Capella' and 'Clara' (Fig. 5). Variety 'Vitra' was too high, is lodging easily and is therefore hard to harvest.

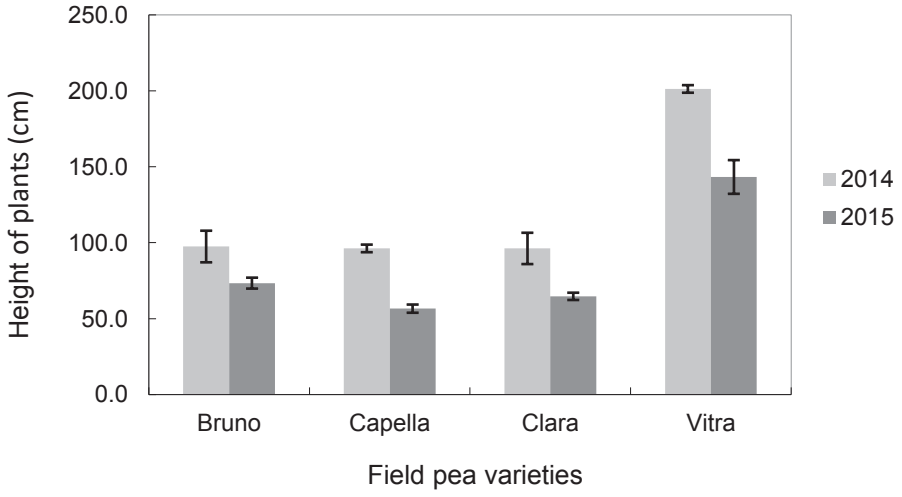

Figure 5. Average height of plants (cm) of different field pea varieties (p in 2014*** and in 2015***).

DISCUSSION

Narits (2008) reported that semi-leafless varieties have a higher seed yield, while in present investigation the seed yield from semi-leafless varieties in 2015 had both marks, the highest ('Bruno') and the lowest ('Capella'), letting leafy variety ('Vitra') to be in the middle. Probably this cold spring and quite cold summer were very suitable exactly for variety 'Bruno' growth and yielding, because just in 2014 there was a tendency that variety 'Bruno' was lowest in yield. In the years when the weather conditions favoured vegetative growth leafed types gave a higher yield and better quality than semi-leafless varieties (Kalev & Narits, 2004). They also noticed that in the year of unfavourable weather conditions the situation was the opposite. Accordingly, Kotlarz et al. (2011) reported that unfavourable weather conditions may negatively influence the crop yield.

The most suitable height of field peas is in a range of 60–100 cm, because the plants with such a height are most effectively suppressing weeds and plants are stronger against lodging, while last mentioned is differing among different varieties. In present investigation in 2014 the height of variety 'Vitra' was around 200 cm, and it in both years strongly lodged, it means this variety is hard to grow and more harder to harvest, even if yield is not bad.

Differences in climate, soil, varieties, agronomic practices may cause a different crude protein content when grown in various parts of the world. The results obtained in this study are showing us that genotype had a significant influence on the levels of crude protein in the field pea (Wang & Daun, 2004). In accordance Witten et al. (2015) describes that the variety of field peas has an influence on its crude protein content. In addition they revealed that environmental conditions and agronomic practice have strong influence on pulse seed quality. Kotlarz et al. (2011) found similarly with results from present investigation that the varieties differed in protein content. Narits (2008) concluded that when the field pea is grown for seed with the aim to get a high protein yield, then attention to the leaf type is important as leafy types usually have a higher protein content. In present investigation it was the same situation in 2015.

CONCLUSIONS

Based on the results of present investigation it can be concluded followed:

1. Out of those four varieties the most suitable varieties for production in Estonian agro-climatic conditions are 'Bruno' and 'Capella', because they have quite high yield and protein content together with suitable height. Variety 'Clara' has quite low protein content and variety 'Vitra' is too heigh and very susceptible for lodging.
2. Choice of the right variety for pea cultivation is very important, but depends on the local agro-climatic conditions. As in Baltic – Nordic countries the agro-climatic conditions are more or less similar the results could be useful also for those countries. Both varieties 'Bruno' and 'Capella' have suitable height and quite high protein content.

ACKNOWLEDGEMENTS. This investigation has been developed with the help of the project EUROLEGUME, funded from the European Union Seventh Framework Programme for Research, Technological Development and Demonstration under the grant agreement No. 613781.

REFERENCES

Astover, A. 2005. *Eesti mullastik ja muldade kasutussobivus* (Estonian soils and their suitability for use). Eesti Maaülikool (Estonian University of Life Sciences), Tartu, 22 p. (in Estonian).

Bastianelli, D., Grosjean, F., Peyronnet, C., Duparque, M. & Régnier, J.M. 1998. Feeding value of pea (Pisum sativum L.) 1. Chemical composition of different categories of pea. *Animal Science* **67**, 609–619.

Blixt, S. 1978. Problems relating to pea breeding. *Agri Hortique Genetica* **36**, 56–87.

Brežna, B., Hudecova, L. & Kuchta, T. 2006. Detection of pea in food by real-time polymerase chain reaction (PCR). *European Food Research and Technology* **222**(5–6), pp. 600–603.

Burstin, J., Marget, P., Huart, M., Moessner, A., Mangin, B., Duchene, C., Desprez, B., Munier-Jolain, N. & Duc, G. 2007. Developmental genes have pleiotropic effects on plant morphology and source capacity, eventually impacting on seed protein content and productivity in pea. *Plant Physiology* **144**, 768–781.

Gabriel, I., Lessire, M., Juin, H., Burstin, J., Duc, G., Quillien, L., Thibault, J.N., Leconte, M., Hallouis, J.M., Ganier, P., Meziere, N. & Seve, B. 2008a. Variation in seed protein digestion of different pea (Pisum sativum L.) genotypes by cecectomized broiler chickens: 1. endogenous amino acid losses, true digestibility and in vitro hydrolysis of proteins. *Livestock Science* **113**, 251–261.

Gabriel, I., Quillien, L., Cassecuelle, F., Marget, P., Juin, H., Lessire, M., Seve, B., Duc, G. & Burstin, J. 2008b. Variation in seed protein digestion of different pea (Pisum sativum L.) genotypes by cecectomized broiler chickens: 2. Relation between in vivo protein digestibility and pea seed characteristics, and identification of resistant pea polypeptides. *Livestock Science* **113**, 262–273.

Harmankaya, M., Özcan, M.M., Karadas, S. & Ceuhan, E. 2010. Protein and mineral contents of pea (*Pisum sativum* L.) genotypes grown in Central Anatolian region of Turkey. *South Western Journal of Horticulture, Biology and Environment* **1**(2), 159–165.

Hedley, C.L. 2001. *Introduction in Carbohydrate in grain legume seeds. Improving Nutritional Quality and Agronomic Characteristics.* John Innes Centre, Norwich, UK, 322 pp.

Jabeen, T., Iqbal, P. & Khalil, I. A. 1988. Amino acid and mineral composition of pea cultivars grown in Peshawar. *Pakistan J. Agric. Res.* **9**(2), 171–175.

Jeuffroy, M.H. & Ney, B. 1997. Crop physiology and productivity. *Field Crop Research* **53**, 3–16.

Dahl, W.J., Foster, J.M. & Tyler, R.T. 2012. Review of the health benefits of peas (Pisum sativum L.). *British Journal of Nutrition* **108**, 3–10.

Kalev, S. & Narits, L. 2004. Weather effects on yield and quality of yield of different field pea types. *Agraarteadus* **1**, 3–11 (in Estonian).

Kotlarz, A., Sujak A., Strobel, W. & Grzesiak, W. 2011. Chemical composition and nutritive value of protein of the pea seeds – effect of harvesting year and variety. *Vegetable Crops Research Bulletin* **75**, 57–69.

Monti, L.M., De Pace, C. & Scarascia Mugnozza, G.T. 1991. Faba bean (Vicia faba L.) cultivation and research in Italy. *Options Méditerranéennes – Série Séminaires* **10**, 143–151.

Narits, L. 2008. The yield and protein content of field peas (Põldherne saak ja proteiinisisaldus). *Agronoomia* pp. 63–66 (in Estonian).

Olle, M. 2015. Which varieties of field peas to grow? (Milliseid hernesorte kasvatada?) *Maamajandus* **10**(40), 17.12.15, 4−4.

Olle, M., Narits, L. & Williams, I.H. 2015. The influence of variety on the yield and content of protein and nutrients of peas (*Pisum sativum*). *21st International Scientific Conference Research for Rural Development 2015.* Latvia University of Agriculture, pp. 45–50.

Patterson, C.A., Maskus, A. & Dupasquier, C. 2009. Pulse crops for health. *Cereal Foods World* **54**(3), 108–112.

Poggio, S.L., Satorre, E.H., Dethiou, S. & Gonzallo, G.M. 2005. Pod and seed numbers as a function of photothermal quotient during the seed set season of field peas (*Pisum sativum*) crop. *European Journal of Agronomy* **22**, 55–69

Pratap, A. 2011. *Biology and breeding of food legumes.* Indian Institute of Pulses Research. 432 pp.

Rodino, A.P., Nistal, J.H., Hermida, M., Santalla, M. & De Ron, A.M. 2009. Sources of variation for sustainable field pea breeding. *Euphytica* **166**, 95–107.

Saastamoinen, M., Eurola, M. & Hietaniemi, V. 2013. The Chemical Quality of Some Legumes, Peas, Fava Beans, Blue and White Lupins and Soybeans Cultivated in Finland. *Journal of Agricultural Science and Technology B* **3**, 92–100.

Strauß R., Bleiholder, H., Boom, T., Buhr, L., Hack, H., Heß, M., Klose, R., Meier, U. & Weber, E. 1994. *Standard coding of phenological growth stages of mono- and dicotyledonous plants.* erweiterte BBCH-Skala; allgemein, Kulturen. Biologische Bundesanst. für Land-und Forstwirtschaft (in German).

Wang, N. & Daun, J. K. 2004. Effect of variety and crude protein content on nutrients and certain antinutrients in field peas (*Pisum sativum*). *Journal of the Science of Food and Agriculture* **84**, 1021–1029.

Witten, S. Böhm, H. & Aulrich, K. 2015. Effect of variety and environment on the contents of crude nutrients, lysine, methionine and cysteine in organically produced field peas (Pisum sativum L.) and field beans (Vicia faba L.). *Appl Agric Forestry Res ¾*, 205–216.