SOYBEAN, LENTIL, CHICKPEA: NON-TRADITIONAL LEGUMES FOR AGRICULTURAL SUSTAINABILITY IN LITHUANIA

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Grain legumes form root nodules which contain symbiotic bacteria fixing atmospheric nitrogen, which is a significant economic and ecological advantage for a sustainable crop rotation. In the European Union (EU), the demand for protein-rich crops greatly exceeds the level of home production. Field pea and faba bean are the main protein crops cultivated in Lithuania, while soybean, lentil and chickpea are common in the tropical climate countries. Attempts are made to reduce the reliance on the imports of these non-traditional crops by investigating novel cultivars adapted to the cultivation environments of temperate agro-climatic region.

Experiments with soybean, lentil and chickpea were conducted in Lithuania, which lies above the northern boundary of typical distribution regions of these species. The experimental plots were established in Dotnuva at Institute of Agriculture, LAMMC, on the organically managed sites in 2015 for soybean and in 2018 for lentil and chickpea. The main objective of this study was to evaluate management practices for the cultivation of the non-traditional legume species. Factors investigated: inoculation (inoculated; not inoculated), rows spacing (12.5, 25, 37.5, 50 and 75cm), three sowing dates and seed rates differing between the species and years, weed control methods (natural crop-weed competition, harrowing, manual weeding and inter-row cultivation). Yield components, maturity and nodulation were assessed during the growing seasons of 2015 and 2016.

A four-year investigation of soybean cultivation generated relevant results based on which cultivation recommendations were prepared. The yield of soybean varied from 836 to 2978 kg ha^{-1} under the influence of the crop and soil management practices. Sowing date was the most important factor for soybean germination. In 2015, sowing date May 25 was more favorable than May 12. In 2016, late sowing date, June 3, resulted in 25 - 48 % yield reduction compared with May 20. Row spacing had a significant effect on the plant population density and consequently on the yield. Plants grown with a 50 cm row spacing tended to accumulate higher aboveground biomass, higher number of seeds per plant and higher seed weight compared with the plants grown with a 25 cm row spacing. Nevertheless, the plots sown at a 25 cm row spacing had 1.3 - 2.6 times higher plant population density which resulted in significantly higher grain yield.

In the variety testing trials we examined seven soybean varieties (Merlin, Violetta, Bohemians, Silesia, Brunensis, De-013-130660, H-15-007-0072) and two B. japonicum strains (‘AGF78’ and ‘2490’). Soybean yield significantly correlated with the biomass of B. japonicum nodules. Inoculated soybean accumulated 98 % higher grain yield, 7 % higher seed weight and 6 % higher protein content compared with not inoculated. Of the two B. japonicum strains, 16 % more effective nodulation was observed for ‘AGF78’ than for ‘2490’. In northeastern European climatic conditions, significantly greater N content and %Ndfa was shown by the soybean variety Merlin in symbiosis with ‘AGF78’ strain. Not-inoculated soybean could not establish symbiosis with native rhizobium bacteria, therefore soybean biomass and productivity declined due to nitrogen shortage in the organically managed agro-system.

Experiments with lentils were set up in 2018, when dry weather conditions prevailed. We investigated the effect of seed rate and sowing time on lentil development and productivity. The highest productivity was achieved when sowing lentil early in spring on April 30. Also, a seed rate of 240 kg ha^{-1} was optimal and gave the highest yield increase to 1298 kg ha^{-1}. The most effective row spacing for weed decrease was 12.5 cm. Manual weeding was effective weed control practice, while harrowing did not differ significantly from natural crop-weed competition. Lentils were able to form symbiosis with local rhizobium bacteria and did not suffer from shortage of nitrogen derived from the atmosphere.

In the first year of chickpea investigation, it produced a low yield ranging between 391 – 809 kg ha^{-1} depending on the seed rate and sowing time. The highest productivity was demonstrated by sowing chickpea at the earliest date, April 30, and at the highest seed rate of 190 kg ha^{-1}. Chickpea exhibited high competitive ability against weeds, while harrowing decreased crop plant density and consequently the yield. The best row spacing was 25 cm. Chickpea also requires special rhizobium bacteria, but even after inoculation, it failed to form nodules for nitrogen fixation this year.

These data show that soybean, lentil and chickpea have the potential to be cultivated under Lithuanian conditions in organic agro-ecosystems. However, the preliminary findings of the first experimental year show better performance and therefore better prospects for lentils than chickpea. Yet, in order to draw more valid conclusions the study needs to be continued for a longer period.