Abstract

Title: **The Effect of Selected Agronomic Factors on Gas Exchange, Yield and Health Status of Soybean (*Glicyne max* L.) Seeds**

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Key words: soybean, nitrogen fertilization, rhizobia, morphological traits, yield components, photosynthesis and transpiration, seed yield, protein yield, seed health

Soybean (*Glicyne max* L.) is considered one of the most important crops worldwide due to its numerous uses. Soybean seeds contain large amounts of valuable protein with a desirable amino acid composition and fat with a high content of unsaturated fatty acids. Therefore, they are used mostly for the production of high-protein livestock feed as well as in the food processing, chemical, pharmaceutical and cosmetic industries. Soybeans have a deep and large root system, which contributes to improving the physicochemical structure of soil. This legume species establishes symbiotic relationships with rhizobia (*Bradyrhizobium japonicum)* that fix atmospheric nitrogen, thus enriching the soil with this nutrient. Soybean cultivation has attracted an increasing interest in recent years in Poland. The development and yield of soybeans are affected by numerous factors such as nitrogen fertilization and the introduction of rhizobia (*Bradyrhizobium japonicum*) to the environment.

In view of the above, the aim of this study was to evaluate the effect of different nitrogen rates and inoculation with *Bradyrhizobium japonicum* on the morphological traits, yield components, gas exchange parameters, the yield and health status of seeds in two soybean cultivars.

It was found that the morphological traits, yield components and seed yield of the analyzed soybean cultivars were modified by weather conditions during the growing season, cultivar, nitrogen fertilization and seed inoculation. Cultivar Annushka was characterized by taller plants and a higher number of pods per plant than cv. Aldana. Aldana produced a higher number of seeds per pod and had higher thousand seed weight. Soybean plants were tallest in the following treatments: 60 kg N · ha^{-1}, 60 kg N · ha^{-1} + Nitragina and 60 kg N · ha^{-1} + Hi Stick. Seed inoculation with Hi Stick, and seed inoculation with Hi Stick combined with nitrogen fertilization at 30 and 60 kg N · ha^{-1} exerted the greatest influence on the number of pods per plant and thousand seed weight. Throughout the study, the average number of seeds per pod was highest in the Hi Stick and 60 kg N · ha^{-1} + Hi Stick treatments. Seed yields were comparable in both cultivars,

and the highest seed yield was noted in 2018 when weather conditions were conducive to soybean growth and development. The highest seed yields were achieved in the treatments where seeds were inoculated with Hi Stick and where Hi Stick was combined with nitrogen fertilization at 30 and 60 kg N · ha^{-1}, which increased seed yield by 40.3 %, 43.3 % and 41.9 % relative to the control treatment. Total protein yield was also highest in the above treatments. The rate of photosynthesis was highest in cv. Aldana in 2018 in the Hi Stick treatment. The rates of photosynthesis and transpiration were higher at the beginning of flowering. The seeds of cv. Annushka were characterized by higher levels of fungal colonization that the seeds of cv. Aldana. The highest number of fungal isolates were obtained from the seeds of cv. Annushka in 2017. Fungal colonies that emerged on the anatomical parts of soybean seeds were represented by the following saprotrophic genera and species: *Alternaria alternata*, *Cladosporium cladosporioides*, *Penicillium* spp. and *Rhizopus nigricans*, which accounted for 90.8 % of all isolates. Pathogens were represented mainly by fungi of the genus *Fusarium*, and they accounted for 9.2 % of all isolates.The results of three-year phytopathological analyses show that the severity of fungal colonization was highest in seeds inoculated with Hi Stick and in the control treatment. qPCR revealed the presence of the toxin-producing species *P. verrucosum* and *Fusarium* fungi in different anatomical parts of seeds in both soybean cultivars.