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The Effects of Drought and Nitrogen on Soybean (Glycine max (L.) Merrill) Physiology and Yield

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Abstract : Legume crops are able to fix atmospheric nitrogen by the symbiotic relation with specific bacteria, which allows the use of the mineral nitrogen-fertilizer to be reduced, or even excluded, resulting in more profit for the farmers and less pollution for the environment. Soybean (Glycine max (L.) Merrill) is one of the most important legumes with its high content of both protein and oil. However, it is recommended to combine the two nitrogen sources under stress conditions in order to overcome its negative effects. Drought stress is one of the most important abiotic stresses that increasingly limits soybean yields. A precise rate of mineral nitrogen under drought conditions is not confirmed, as it depends on many factors; soybean yield-potential and soil-nitrogen content to name a few. An experiment was conducted during 2017 growing season in Debrecen, Hungary to investigate the effects of nitrogen source on the physiology and the yield of the soybean cultivar 'Boglár'. Three N-fertilizer rates including no N-fertilizer (0 N), 35 kg ha⁻¹ of N-fertilizer (35 N) and 105 kg ha⁻¹ of N-fertilizer (105 N) were applied under three different irrigation regimes; severe drought stress (SD), moderate drought stress (MD) and control with no drought stress (ND). Half of the seeds in each treatment were pre-inoculated with Bradyrhizobium japonicum inoculant. The overall results showed significant differences associated with fertilization and irrigation, but not with inoculation. Increasing N rate was mostly accompanied with increased chlorophyll content and leaf area index, whereas it positively affected the plant height only when the drought was waived off. Plant height was the lowest under severe drought, regardless of inoculation and N-fertilizer application and rate. Inoculation increased the yield when there was no drought, and a low rate of N-fertilizer increased the yield furthermore; however, the high rate of N-fertilizer decreased the yield to a level even less than the inoculated control. On the other hand, the yield of non-inoculated plants increased as the N-fertilizer rate increased. Under drought conditions, adding N-fertilizer increased the yield of the non-inoculated plants compared to their inoculated counterparts; moreover, the high rate of N-fertilizer resulted in the best yield. Regardless of inoculation, the mean yield of the three fertilization rates was better when the water amount increased. It was concluded that applying N-fertilizer to provide the nitrogen needed by soybean plants, with the absence of N₂-fixation process, is very important. Moreover, adding relatively high rate of N-fertilizer is very important under severe drought stress to alleviate the drought negative effects. Further research to recommend the best N-fertilizer rate to inoculated soybean under drought stress conditions should be executed.

Keywords : drought stress, inoculation, N-fertilizer, soybean physiology, yield
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