Abstract

Low-temperature plasma generated at atmospheric pressure seems to be the good alternative to classical chemical way to improve germination and growing parameters of plant seeds. However, for the application of plasma technology, it is important to study the effect of plasma and its individual compounds on the seed as well as in detail the parameters of plasma and set the appropriate experimental conditions for the plasma treatment of seeds. In the submitted dissertation work we deal with the diagnostics of low-temperature plasma generated by diffuse coplanar surface barrier discharge (DCSBD) for the purpose of better understanding the mechanism of the DCSBD plasma effect on soybean and pea seeds. Using optical emission spectroscopy, we determined the rotational and vibrational temperatures, the difference of which is around the level of several thousand kelvins, which confirmed the strongly nonequilibrium character of the DCSBD plasma. We also proved the presence of reactive oxygen and nitrogen species in plasma by analysing gaseous plasma products using FTIR spectroscopy, which play a role in the interaction of plasma with the seed surface. Based on previous research, DCSBD plasma generated in ambient air seems to be the most efficient for use in plasma seed treatment, so we used as working gases not only air but also combinations of its basic components such as nitrogen and oxygen mixtures in various ratios or synthetic air with different values of humidity. The plasma generated in oxygen contains a large amount of ozone O_3. The air plasma contains mainly nitrogen oxides NO_2 and N_2O as well as UV radiation. The intensity of the plasma radiation increases with increasing amount of nitrogen in the working gas. The increase in the humidity of synthetic air as a working gas causes an increase in the concentration of NO_2 and N_2O in plasma gaseous products. The results of the study of the interaction mechanism between plasma and soybean and pea seeds confirm that not only the type of individual components of plasma but also the duration of their action plays an important role. The shorter exposure of individual plasma compounds has a positive effect on seeds, after the longer exposure of plasma, generated mainly in pure nitrogen and oxygen, the seed is damaged. From the results of our study, it can be assumed that the positive effect of plasma on seeds is caused by the synergetic effect of individual components of plasma on seeds, while the ratio of the individual active compounds as well as the plasma treatment time.

Key words: low-temperature plasma, DCSBD discharge, Optical emission spectroscopy, Optical absorption spectroscopy, FTIR spectroscopy, reactive oxygen and nitrogen species