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Photomorphogenesis of embryogenic wheat calluses in edaphic stresses conditions

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We studied the photomorphogenesis of calluses of various wheat species obtained from immature and mature embryos and cultivated both under optimal conditions and under conditions of edaphic stresses (salinity – NaCl, 0.63% and drought - polyethylene glycol, 16% w/v). PA of calluses was recorded at the day of their passaging to the stress proliferation medium and then on third, seventh and fifteenth day of cultivation. The data recorded at PPFD of 20 µmol/m2s were involved into analysis of Y(II), Y(NO) and Y(NPQ) parameters. When visualizing the maximum quantum yield of photosynthesis of photosynthetic system II (PSII) calluses obtained from immature embryos, the active formation of chlorophyll-containing areas (CCA) was noted on the optimal background. The two-peak shape of callus PA dynamic curves of these two species was similar to those described in other work conducted with spring wheat, as shown Stupko and Zobova earlier. Probably the second peak is associated with increase of PA of existing CCA. In the process of photomorphogenesis, species-specific differences were revealed. The maximum frequency of callusogenesis was observed in hexaploid forms, the minimum frequency in diploid species of *T. monococcum*. The calluses of tetraploid species of *T. dicoccum*, *T. polonicum*, *T. aethiopicum*, and hexaploid *T. aestivum* in control conditions were significantly superior to other species in the growth of raw biomass. The process of histogenesis was accompanied by the mass formation of trachea-like structures, which are ringed or spiral formations that grow green in the light. Chloroplasts in zones of somatic embryogenesis were similar to chloroplasts of leaf mesophyll cells. But in contrast to intact plants, in which chloroplasts cells are usually located near the wall in the calluses the arrangement of chloroplasts was predominantly chaotic. The stressful action led to the processes of degeneration of the photomorphogenic tissues and the destruction of CCA and trachea-like structures, primarily in the calluses of less stable species. The most active processes of photomorphogenesis under stress conditions are found in calluses which have a relatively small increase in the biomass of cell colonies. This is confirmed by reveals the negative correlations between Y(II) and Y(NO) and callus weight ($r = -0.5^{*}$, $r = -0.7^{**}$) and between the same parameters of quantum yield and relative callus weight growth (stress / control %) ($r = -0.9^{***}$ и $r = -1^{***}$) under drought conditions. The salt stressed calluses often characterized by high weight due to high level of risogenesis. Relations between Y(II) and Y(NO) and relative callus weight growth (stress / control %) are described by coefficients of $r = 0.6^{*}$ и $r = 0.9^{***}$ respectively.

A large percentage of regenerating plants under drought conditions *in vitro* was noted in species *T. dicoccum* (67%) and *T. aestivum* (50%), under salt stress conditions – in species *T. compactum* (80%), *T. polonicum* (65%), *T. dicoccum* (50%), *T. macha* (50%), *T. aestivum* (50%).

For the purpose of optimization of photosynthetic callus culture development, the attempt of PA analysis of callus culture, developed from mature embryos. Data on PA of calluses, developed from mature embryos, had wide scatter. The dynamic of PA of other species refers their culture to old ones. The effectiveness of their photosynthetic reaction decrease with time on all media including optimal background. Also Y(NO) of these calluses increased in that course. So we couldn't distinguish the influence of stress on the culture. Such data recorded on optimal media can be the evidence of no CCA active grows. Therefore, for the purpose of photosynthetic active callus culture of described wheat species production the immature embryos are more suitable then mature ones.