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## **NITRIC OXIDE AS MEDIATOR IN INDUCTION OF HEAT RESISTANCE OF WHEAT SEEDLINGS BY DONOR OF CARBON MONOXIDE HEMINE**

Carbon monoxide (CO), as a signal molecule-gasotransmitter, is involved in the regulation of plant growth, development and formation of adaptive responses to stress factors (Santa-Cruz et al., 2010; Lin et al., 2014; Xie et al., 2014). A positive effect of carbon monoxide donors (in particular, hemin and hematin) on plant resistance under the action of stressors of various natures (dehydration, salt stress, heavy metals, etc.) has been established (Liu et al., 2010; Zhang et al., 2012; Chen et al., 2018). At the same time, the effect of exogenous carbon monoxide on plant resistance to stress temperatures remains poorly understood. The increase in the survival of tobacco cell culture after damaging heating under the influence of hematin has been shown (Li, Gu, 2016). We have shown the induction of the development of heat resistance in intact wheat seedlings by CO donor hemin (Shkliarevskiy et al., 2020).

The physiological effects of carbon monoxide are mediated by other signal mediators. One of them, possibly, is another gasotransmitter – nitric oxide (NO). Xie et al. (2008) have showed that exogenous CO enhanced the synthesis of nitric oxide in wheat seedlings roots under salt stress conditions, while the NO synthase inhibitor N<sup>G</sup>-nitro-L-arginine methyl ester (L-NAME) and nitric oxide scavenger methylene blue suppressed the increase in NO content, and removed the protective effect of CO. The role of NO as a mediator in the implementation of stress-protective effects of CO is also indicated by the levelling of the positive effect of hematin - the inductor of heme oxygenase 1 - on wheat seedlings exposed to osmotic stress under the treatment with nitric oxide scavenger 2-phenyl-4,4,5,5-tetramethylimidazoline-1-oxyl-3-oxide (PTIO) (Liu et al., 2010). The participation of nitric oxide in CO-

induced stomatal closure has been shown (Song et al., 2008). However, the question remains open about the role of NO in the realization of the development of plants heat resistance induced by exogenous CO. For this purpose, the endogenous content of NO in roots of wheat (*Triticum aestivum* L.) seedlings of Doskonala variety after the treatment with hemin, and also the effects of NO scavenger PTIO and inhibitors of enzymes of nitric monoxide synthesis on the development of heat resistance of wheat seedlings have been studied.

It was shown that after 24-hour exposure of intact seedlings on a medium with 5  $\mu$ M hemin, their heat resistance increased markedly. At the same time, already in 1 h after the beginning of exposure, the content of NO increased in the roots of seedlings, in 2 h this effect decreased, and in 4 h indicators were identical to the control. The effect of increasing the NO content

in roots caused by treatment with hemin was almost completely eliminated by the inhibitor of nitrate reductase sodium tungstate, but not by the inhibitor of NO synthase aminoguanidine.

The increase in the heat resistance of seedlings caused by CO donor was levelled by preliminary treatment with the NO scavenger PTIO and the nitrate reductase inhibitor  $\text{Na}_2\text{WO}_4$ . At the same time, the NO synthase inhibitor aminoguanidine slightly reduced the manifestation of hemin effect on the heat resistance of wheat seedlings. A conclusion has been made about a contribution of nitric oxide, which is synthesized with the participation of nitrate reductase, in the development of CO donor-induced heat resistance of wheat seedlings.

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*Key words:* carbon monoxide, nitric monoxide, nitrate reductase, heat resistance, *Triticum aestivum*