Response and adaptation of soybean plants to waterlogging stress
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湛水ストレスに対するダイズの反応と適応
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Waterlogging is a major problem for farmers because it enhances losses in crop production. Soybean \([\textit{Glycine max} \ (\text{L.}) \ Merrill]\) is sensitive to waterlogging, which negatively affects its seed germination, seedling establishment, and growth, leading to a serious reduction in its productivity. This mini symposium will briefly review response and adaptation of soybean plants to waterlogging stress, with a focus on the genetic improvement of soybean.

Waterlogging injury to germinating seeds
Water is rapidly absorbed by seeds when they are sown in excessively moist soils or sudden rainfall occurs immediately after sowing. Such conditions lead to the collapse of the cotyledon and radicle, negatively affecting the germination and seedling establishment (Nakayama et al., 2004). According to Jitsuyama et al. (2012), the seed of the soybean cultivar Hayahikari absorbs water extremely slowly; this prevents it from waterlogging injury.

Risk of phytophthora root and stem rot at the seedling stage
Phytophthora root and stem rot has been shown to be far more damaging to soybean seedlings in waterlogged soils than to those in drained soils; thus, this pathogen is a serious problem in the upland paddy fields during the rainy season in Japan. The infected seedlings show symptoms such as soft decay of the lower stem, damping, and wilting. Some soybean varieties possess some race-specific resistance genes. For example, the \(Rps-1k\) gene seems to induce resistance to approximately 80% of the races of the fungus distributed in Japan (Moriwaki, 2010).

Waterlogging injury at the vegetative and flowering stages
Soybean plants suffer from soil waterlogging not only because of oxygen shortage in the soils but also because of the accumulation of toxic cations. The inhibited nutrient uptake, reductions in nodulation and low nitrogen fixation activity lead to leaf chlorosis. The leaf chlorosis indicates a decrease in the photosynthetic activity of the leaf. However, under prolonged waterlogging conditions, soybean plants form new adventitious roots and aerenchyma. Recently, Shoku-kei32, a soybean breeding line in Hokkaido (Hokkaido Central Agricultural Experiment Station) was screened as a genetic resource for improving the waterlogging tolerance of soybean plants at the flowering stage (Kosaka et al., 2010).

Possibility pertaining to genetic improvement of the waterlogging tolerance of soybean
The different waterlogging tolerance of soybean plants at each growth stage and complexity of the trait, hamper their breeding. However, recent evidence has shown a gradual increase in the adaptation potential of soybean plants to waterlogging stress. Therefore, the accumulation of these useful genes will lead to the genetic improvement of soybean waterlogging tolerance.