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Heterogeneity in plant growth of the black pine planted on a coastal embankment along the Sendai Bay area

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Abstract

After the 2011 Tohoku earthquake and Tsunami, the black pine coastal forest has been planned to establish a coastal forest along the seacoast where have been damaged by strong hit of the 3.11 Tsunami. The coastal forest consisting of the black pine has important roles to protect the inland urban and agricultural areas from Tsunami, strong wind, and sand blast. People who lived there have a major concept to keep the coastal forest with the black pine for the future coastal forest. The planting areas with black pine seedlings have gradually extended since 2013. Almost all planned areas have been occupied by the black pine until 2020. However, plant growth in the early planting areas has been heterogenous in managed areas irrespective of the stand ages. We cannot expect future healthy growth of the black pine trees expecting to play a role as a protecting forest against next Tsunami. Regulation factors of less growth of the black pine tree should be clear.

The research area has been set in Sendai City along the Sendai Bay. Several tens planting bases were constructed using sandy soil materials brought from Sendai hills 30 km apart from the coastal area. The planting base was consisting of a basic embankment with 2 m height and a planting base with 1 m height. The embankment with 3 m thickness was constructed to keep deeper ground water level than that of previous coastal forest. We selected four planting bases, which has been established on 2013 followed by planting seedlings on 2014, as survey areas. Growth of the black pine was evaluated by NDVI using remote-sensing data obtained from Sentinel-2 on July 2020. Soil hardness and physico-chemical properties were also obtained at the field survey and laboratory analyses using collected soil samples.

Although there was heterogeneity in plant growth in each study area, the heterogeneity evaluated by the Kernel density estimation of NDVI was different between the survey sites. There was significant difference in clay content between soils in the embankment and the control plot. The physical condition affected by soil texture is one of controlling factors for soil moisture condition relating to the heterogenous plant growth on the artificial plant bases. Moisture rather than nutritional condition will be a major controlling factor to differentiate growth of planted black pines.