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Aluminum bioavailability of aluminum-humus complexes in Andosols

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Non-allophanic Andosols often show aluminum (Al) toxicity to Al-sensitive plant roots. The origin of the toxic Al has been considered to be primarily Al\(^{3+}\) adsorbed on permanently charged sites of 2:1 type minerals. However, it was suggested that Al-humus complexes are one of the pools of toxic Al (Takahashi et al. 2007). In contrast, natural allophanic Andosols rarely show Al toxicity to plant roots although allophanic soils also contain Al-humus complexes. With strong acidification, allophanic Andosols then come to possess toxic Al which injure to plant roots (Takahashi et al. 2008). The origin of the toxic Al in allophanic Andosols is not still clear. The aim of this study is to clarify the origin of bioavailable Al in Andosols using cultivation of Al-sensitive plants and Al-tolerant plants.

Nine A horizon soil samples were used to this study; two typical non-allophanic soils (pH (H\(_2\)O) 4.4-4.7), their limed soils (pH (H\(_2\)O) 6.0), two typical allophanic soils (pH (H\(_2\)O) 5.7-7.0), three acidified allophanic soils (pH (H\(_2\)O) 4.6-5.4). We cultivated burdock (Arctium lappa) and barley (Hordeum vulgare) as Al-sensitive plants and buckwheat (Fagopyrum esclentum) as an Al-tolerant plant. We measured the root lengths of burdock and barley after 4-day culture, and determined Al concentrations of buckwheat plants after a month culture.

Typical non-allophanic soils showed strong toxicity of Al to roots of burdock and barley. Although Al toxicity was not observed in the typical allophanic soils in the Al-sensitive plants, acidified allophanic soils did show the toxicity as observed in the non-allophanic soils.

Reflecting the toxicity (bioavailability) of these soils, Al concentrations in buckwheat plants grown in non-allophanic soils were much higher (2.6-4.3 mg kg\(^{-1}\)) than those in typical allophanic soils (0.4-1.4 mg kg\(^{-1}\)). However, those concentrations of buckwheat in acidified allophanic soils were comparable (2.7-4.0 mg kg\(^{-1}\)) to those in the non-allophanic soils. Because these allophanic Andosols contained few 2:1 type minerals, it is assumed that Al\(^{3+}\) adsorbed on permanently charged sites of the minerals is not abundant. Therefore, we considered that Al-humus complexes play important roles of Al toxicity (availability) in the acidified allophanic Andosols as well as non-allophanic Andosols.

References
