

学位論文題名

Population and ecological studies of the invasive pioneer species *Chromolaena odorata* and the application on post-mining land restoration and forest regeneration

(外来侵入植物ヒマワリヒヨドリ (*Chromolaena odorata*) の個体群生態学的研究とその鉱山跡地の再生および森林回復への応用)

学位論文内容の要旨

The invasive weed *Chromolaena odorata* grows prominently among the early colonizers after habitat disturbance in Ghana. This study showed that the highest percentage of plants cover per 10 x 10 m plot was 65% in the tropical rainforest and 60% within the deciduous forest sites. The percentages were significantly ($p < 0.001$) higher than within the coastal savanna (18%) and Guinea savanna (5%). No *C. odorata* cover (0%) was recorded for the Sudan savanna and mangrove swamp zones.

A quantitative survey of the national distribution of *C. odorata* in 15 x 15 m in experimental plots conducted across five ecological zones. The mean leaf area, leaf density, shoot height, canopy diameter and main stem diameter was surveyed. The tropical forest biomes (tropical rainforest and deciduous tropical forest) depicted the highest leaf density, widest leaf area, main stem diameter and plant canopy diameter deciduous tropical forest. These variables were significantly ($p < 0.001$) higher than the magnitude of plant traits within the coastal savanna and Guinea savanna.

In a study that covered three undisturbed tropical forest sites and three neighboring mine wasteland sites (2 - 15 years post-mining), the growth vigor of *C. odorata* was compared to that of a dominant native plant species *Panicum maximum*. The native species *P. maximum* showed lower growth vigor (in terms of phenotypic trait) in the disturbed abandoned mine sites when compared to the undisturbed forest sites. The mean mortality rate was 55% and 5% within the mined lands and the undisturbed forest sites respectively. The limitation induced by dense canopy shade may be among the potential factors that facilitate the invasiveness of *C. odorata* and the capacity to spread.

However, the mean leaf density per plant was significantly higher ($p < 0.0001$) among *C. odorata* in mine lands than in undisturbed forests. *C. odorata* showed significantly ($p < 0.0001$) higher plant density in the abandoned mine lands. This might suggest the suitability of disturbed mined lands as habitats that facilitate invasive characteristics among the species. Approximately 65 % mortality rate occurred among *C. odorata* beneath the dense canopy of the undisturbed forest sites

and recorded just 4 % mortality rate within the mined land sites.

Seeds from the wet tropics infestation areas in a primary and a secondary forest in Australia (50 seeds each were set in a Randomized Complete Block Design of four treatments and three replications) were incubated in 1.5 cm x 9.0 cm deep petri dishes in an incubator at a mean temperature 30 °C. The trend of germination of *C. odorata* seeds in response to salinity, smoke, acid and alkaline was investigated. Smoked seeds germinated significantly ($p < 0.0001$) higher in the water than in soil.

The percentage seed germination in smoke treatment was significantly ($p < 0.001$) higher than in non-smoke conditions. The germination rate in both primary and secondary forests was higher under low sodium chloride (NaCl) concentration (0.02 mol L⁻¹, 0.04 mol L⁻¹, 0.06 mol L⁻¹ and 0.08 mol L⁻¹).

The seedlings of *Chromolaena odorata*, *Citrullus vulgaris*, *Leucaena leucocephala* and *Voacanga africana* were tested for their tolerance to salinity stress (Na⁺) and metallic ion (Al³⁺, Mg²⁺, Fe²⁺) toxicity. The tolerance of salinity and of Al and Mg toxicity stress was determined by the comparative variation in the physiological traits change under the control treatment. The variation in the plant biomass (phytomass) change was based on shoots and roots dry weight (g).

The results showed that strong acidity produced acute wilting, stunted growth, chlorosis and necrosis. Al³⁺ induced acute wilting in younger seedlings and leaf necrosis among the juvenile seedlings. *C. odorata* depicted a high stress tolerance index (STI: 1.05). *C. odorata* may not be suitable for revegetation on highly contaminated soils as the seedlings might be predisposed to necrosis. *C. odorata* establishment could be applied to the revegetation of non-contaminated mine lands, due the relatively poor survival rate on highly contaminated sites. However, the study shows that *C. odorata* could be adapted for the revegetation of less contaminated mine tailings to avoid soil erosion and fertility loss.

学位論文審査の要旨

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The examination committee recognized that this study provides new insights into the possibility of utilizing the invasive plant for revegetation activity on post-mining land sites. The committee thereby concluded that the applicant is eligible for the degree of Doctor of Philosophy (Environmental Science).