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LITTERFALL, ABOVE-AND BELOWGROUND BIOMASS AND SOIL, PROPERTIES DURING THE FIRST YEAR OF A *CHROMOLAENA ODORATA* FALLOW

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ABSTRACT

Soil improvement by a fallow vegetation can be based on above- and below-ground biomass incorporated to the soil at converting a fallow to cropped land, but also to litterfall and changes in soil organic matter fractions during the fallow period. To test a hypothesis on soil fertility improvement by *Chromolaena odorata*, a replicated trial was set up to compare it to other fallow species: *Imperata cylindrica* (the default grass fallow), *Pueraria phaseoloides* (a N_2-fixing legume) and *Peltophorum dasyrrachis* (a deep-rooted local tree). Initial results on biomass and soil changes during the fallow are reported here.

From the three planted fallows, *Chromolaena* had the largest aboveground biomass at 6 months after planting, but after 12 months *Peltophorum* had the highest biomass (32 Mg ha^{-1}) and *Pueraria* the lowest (7.5 Mg ha^{-1}), with an intermediate value for *Chromolaena* (12.5 Mg ha^{-1}). Shoot: root ratios were around 3:1 for *Chromolaena* and around 2: 1 for *Imperata*. Shoot: root ratios were high (around 10: 1) in early stages of the

Pueraria and Peltophorum fallow vegetation, but were later reduced to around 5 : 1. Root length density at all depths for all planted fallows remained less than that of *Imperata*. At 11 MAP all fallows had a root length density of more than 0.1 cm cm^{-3} up to a depth of about 80 cm. Root length densities of well established *Chromolaena* stands outside the experiment were well below that of *Imperata* at all depths. Litterfall from *Peltophorum* and *Chromolaena* was 2.5 and 3 Mg ha^{-1}, respectively, in the first year after planting, but subsequently litterfall from *Peltophorum* exceeded that from *Chromolaena;* from May 1995 to May 1996 *Peltophorum* shed 6.5 and *Chromolaena* nearly 4 Mg ha^{-1} of leaves. Chemical soil analysis revealed no clear differences during the first half year of fallow development. The well-developed surface litter layer under spontaneously established *Chromolaena* outside the experiment lead to high values of the light and intermediate fraction of macro-organic matter.

INTRODUCTION

Chromolaena odorata was introduced into Indonesia through Sumatera and Irian Jaya in the beginning of the 20th century as soil-improving cover crop (Tjitrosoedirdjo *et al.*, 1991). The plant, a perennial shrublike, has spread rapidly and is now a common constituent of the fallow vegetation on any abandoned crop land. It is considered to be a weed which has to be eradicated by biological control (Obatolu and Agboola, 1993), as it is hardly palatable for cattle and detrimental to young tree crop plantations. However, food-crop farmers generally appreciate *Chromolaena* as a fallow vegetation and definitely prefer it over *Imperata* grasslands, which it may replace under certain conditions. Biological control is not selective in affecting weeds only for certain land use types, and hence the release of biological control agents against *Chromolaena* should consider possible negative consequences for large groups of small farmers. In the debate on this issue, it is important to distinguish whether *Chromolaena* is indeed improving soil fertility and controlling other weeds, or mainly an indicator of fertile soil conditions. Farmer's preference for *Chromolaena* fallows might be based on the latter, and in this case a loss of *Chromolaena* might not be detrimental, as other 'indicators' may replace it.

Although many references indicate that land cleared from *Chromolaena* sustains relatively good crop yields, no conclusive evidence exists that *Chromolaena* actually improves soil fertility, and if so, by what mechanism. A correlation between relatively high soil cation contents and *Chromolaena* abundance on acid soils might be based on selective growth of *Chromolaena* on good sites, as well as on actual improvement of soil conditions, possibly based on the relatively deep root system of *Chromolaena* and a high biomass and litter production. Akobondu and Ekeleme (1996) reported from the humid forest and derived savanna zone in Nigeria that *Chromolaena* produced 4 - 4.5 Mg ha^{-1} yr^{-1} of leaf litter and returned 65 - 80, 5 - 10 and 16 - 24 kg ha^{-1} of N, P and K, respectively. The 'high quality' leaf litter decomposes rapidly. These amounts of dry matter and nutrients are within the range of natural bush fallow vegetation, but the nutrient concentrations and litter quality are relatively high. This may lead to rapid effects on crop growth, but also to a rapid 'burn-out' of the fallow-induced soil fertility.

To test the 'indicator' versus 'agent' interpretation of survey data, experiments are needed with controlled introduction of *Chromolaena* in some plots and not in others to test its effects on the soil. We initiated such a trial, with *Imperata* grassland as comparison as the default fallow, a legume cover crop *Pueraria*, known to enrich soil organic matter content and to supply N to subsequent crops, and the local non-N fixing leguminous tree *Peltophorum dasyrrachis*, known to be deep rooted.

Two hypotheses to be tested are (1) Soil improvement by *Chromolaena* and *Peltophorum* is based on high litter inputs and on topsoil enrichment with cations taken up in deeper soil layers, (2) Soil improvement by *Pueraria* is primarily based on a higher soil N content. We report here on litterfall, above- and belowground biomass of the four fallow types and soil properties in the experiment.

MATERIALS AND METHODS

This study is carried out as part of the BMSF project, a research collaboration between Brawijaya University Malang, and Khon Kaen University-(Thailand), Wye College-(UK), AB-DLO (the Netherlands) and ICRAF S.E. Asia Program. Average annual rainfall is about 2500 mm per year. The site has a four months dry (<100 mm per month) in July-October, and mostly wet (>200 mm) season in November to April.

An experiment was laid out in an existing *Imperata* grassland on an acid ultisol of low fertility. This plot was formerly used as an experimental plot (ridging treatment on maize for 2 years in 1990-1991), and had been invaded by *Imperata* for 3 years prior to the start of the fallow experiment. *Imperata* was slashed manually and all biomass was removed from the land, a week later all plots except for the *Imperata* treatment were sprayed with Glyphosate (Round up 1.5 ml per liter) and the soil was lightly hoed till about 5 cm depth.