Rotational diversification and fertilization together explain the impacts of tropical weeds on rice yields through changes in plant communities and biomass

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Under tropical conditions, weeds grow continuously and cause detrimental yield loss in annual cropping systems. In the rainfed rice-based agroecosystems of the mid-west region of Madagascar, weed pressure is extremely high and could decrease rice yield (until -30 kg.ha^{-1} rice per day of delay of weeding). The impacts of weeds are of greatest concern in such agroecosystems based exclusively on manual fieldwork and where the minimal use of external inputs confers very low soil fertility. To overcome these issues, diversification may be an option to promote yield while reducing weed pressure while fertilization may help the crop to be more competitive against weeds.

Here, we tested the combined effects of plant diversification and fertilization on weed species biomass, composition and diversity in a 4-years field experiment carried out in Ivory, in the mid-west region of Madagascar, with a randomized block design and four replications. We compared three different rainfed rice-based rotations: Rice followed by Groundnut = RG, Rice followed by a mixture of Sorghum and *Vigna unguiculata* =RSV, Rice followed by a mixture of *Mucuna cochinchinensis* and *Crotalaria spectabilis* = RMC; under two levels of fertilization (F1 = manure *vs*. F2 = manure + fertilizer) using rainfed rice monoculture (RR) as control. We assessed weed biomass at each weeding (two per season), and weed composition and diversity at the second weeding only. Finally, we measured rice yields at harvest to evaluate the impact of weeds on rice productivity in the different rotational systems.

We found that weed biomass, composition and diversity were affected by year, the type of rotation and the level of fertilization. Weed biomass was significantly higher in F2 than F1, and significantly lower in RMC than in RG, RSV or RR. Species richness, was higher in RR followed by RMC, RSV and ultimately in RG. In addition, the composition and structure of weed communities differed according to fertilization, year and rotation. Each year differed from the other and RMC differed from the other rotations and control due to the presence of cover crop regrowth and a higher species diversity during the growth of cover crops. Overall, rice yield was negatively correlated to weed biomass in F1.

Diversification of rotations plays a key role in decreasing weed biomass, yet it did not increase weed diversity. Differences observed in terms of weed communities could lead to different degree of harmfulness considering rice and then partly explain the differences observed on rice yield.