UNIVERSITY OF HOHENHEIM

Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) (490)

Management of Crop Water Stress in the Tropics and Subtropics (490g)

# Early source development of lowland rice as affected by variable thermal environments in high altitude cropping systems in Madagascar

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in partial fulfilment for the award of the degree

Master of Science in Agricultural Science –

Plant Production Systems

The study was financially supported by the foundation Fiat panis

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# Abstract

In the highlands of Madagascar rice cultivation is mainly restricted by temperature. Usually one crop is planted per year because of seasonal climate limitations. In order to increase local rice production without expanding the cultivation area, seasonal production windows have to be used more efficiently by either introducing effective crop rotations or double cropping systems. To ensure success, crop responses to variable thermal environments must be accurately predicted.

The focus of the present study lies on thermal responses of early source development of rice. Five contrasting rice genotypes have been selected for assessment of early source development on two sites at three staggered planting dates, hereby creating six different thermal environments. Leaf development and tiller production were assessed in weekly observations at respective experimental sites and related to average air temperature over two weeks preceding the date of observation. Additionally, leaf area and dry matter accumulation was assessed by performing a snap-shot over all available planting dates, with plants at different developmental stages. Gained data was subsequently related to experienced thermal environment, expressed in growing degree days.

Leaf development and respective leaf appearance rates (LAR) were found to be primarily controlled by temperature. A broken-stick regression was applied and a linear thermal response of LAR of the leaves 5 – 8 could be substantiated at mean air temperatures ($Tavg_{2w}$) between 12 °C and 18 °C. Beyond this temperature no significant relation of LAR and temperature could be established. No significant differences in thermal response (slope of the regression line) of LARs could be observed among tested genotypes. $T_{base}$ for development of leaves 5 – 8 was found to be between 8.2 °C and 10.2 °C with significant differences among tested genotypes ($p = 0.0015$). Location factors, particularly water deficit and occurrence of pests, seemed to influence observed LARs, since within overlapping temperature range LARs observed in Ivory were lower than in Ambohibary. Leaf area of single leaves was found to increase with temperature in in four of five tested genotypes ($p < 0.0001$). L/W-ratio of respective leaves likewise increased with temperature in all tested genotypes ($p < 0.001$). Tiller production could rather be related to radiation intensity [W/m²] than to prevailing temperatures. Four of five observed varieties exhibited a significant increase in tillering rates with increasing radiation ($p < 0.02$). Gained data from snap-shot observation coincided with the results obtained from weekly observations of source development, nevertheless the method requires further verification and incorporation of cardinal temperatures for accurate estimation of crop development.