



# Identifying common crop traits to address the variability in tiller production between sorghum and rice canopies

Improving the understanding of the crop response of tiller production to growing conditions, and of its physiological and genetic control, is an essential step towards the design of more adapted plant types to given conditions. A common and focused analysis of tiller dynamics in canopies of genetically-close species like sorghum and rice can greatly contribute to identify similar and contrasted crop strategies and subsequently to localize key genetic regions involved in the control of tiller production.

## Material and methods

Crop growth processes of a high-tillering sorghum hybrid Buster, grown in different plant densities from 2 to 16 plants  $m^{-2}$  in Australia (where it produced up to 6 tillers per plant), and a conventional rice inbred IR72, grown in the Philippines under contrasted growing conditions, like wet and dry seasons, transplanting age from 7 to 35 days or plant density from 25 to 50 plants  $m^{-2}$  (for which it produced up to 30 tillers per plant), were quantified. Leaf and tiller emergence, with identification of tiller origin, were observed twice a week, leaf area was measured destructively once a week with a leaf area meter, relative tillering rate and relative growth rate were calculated from weekly destructive sampling and daily interpolation, and grain yield was determined from a 5 $m^2$  field area at maturity.

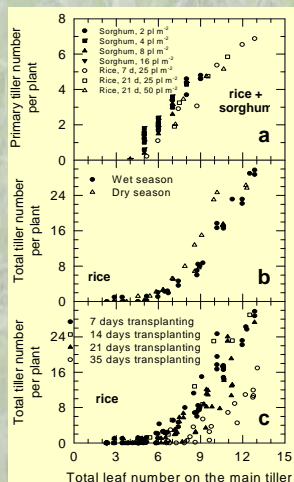


Fig. 1. Changes in emerged tiller number with time when considering only primary tillers for sorghum and rice (a) and whole tillers for rice with different climate conditions (b) and different transplanting age (c).

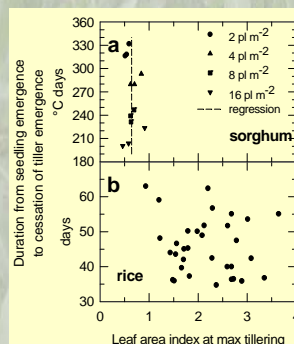


Fig. 2. Relationship between duration of period from seedling emergence to cessation of tiller emergence and LAI calculated at the time of cessation of tiller emergence for sorghum (a) and rice (b).

## Results

● Dynamics in tiller emergence at a single mother tiller level were similar between both species. Rate of primary tiller emergence in sorghum and rice was linearly related to leaf number on the main tiller, with the first tiller emerging at leaf number 5 for sorghum and leaf number 6 for rice (when the incomplete leaf was counted).

● Dynamics of total tiller emergence with leaf number on the main tiller was exponential and was variable with growing conditions like climate conditions and plant density. The variation was even greater when the date of transplanting was delayed, probably generating high competition between seedlings while growing in the nursery and highlighting the impact of plant trophic status on tiller emergence.

● Cessation in tiller emergence in sorghum was correlated to a unique value of leaf area index, 0.6, when plant densities from 2 to 16 plants  $m^{-2}$  were considered. It appeared to be controlled by a crop indicator before any trophic limitation occurs.

● Cessation in tiller emergence in rice occurred, however, with leaf area index ranging from 1.0 to 3.5, or with crop stage ranging from 15 and 2 d before panicle initiation (data not shown), when considering distinct growing seasons, transplanting dates, and plant densities. Tiller emergence may have been stopped in each case due to trophic limitations in the plant.

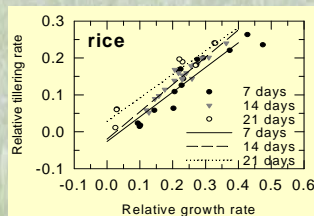


Fig. 3. Relationship between relative growth rate and relative tillering rate for various crop techniques

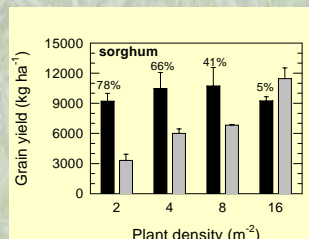


Fig. 4. Grain yield vs plant density in sorghum for tillering (black bars) and unicum (open bars) plants. Unicum plants were obtained by systematically removing primary tillers as soon as they appeared on the plant. Bars represent SEM of three replications. Percentages represent contribution of branch tillers to grain yield.

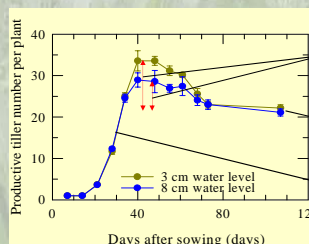


Fig. 5. Changes in number of tillers per plant with time under a continuous water depth of 3 cm and a water depth of 8 cm from mid to maximum tillering.

■ Relative tillering rate was strongly related to relative growth rate (RGR) in rice. The slope was stable for a range of transplanting ages but the critical RGR for cessation in tiller emergence seemed to differ with growing conditions.

■ The impact of tiller mortality on grain yield was contrasted between sorghum and rice. Grain yield of sorghum, when grown at 16 plants  $m^{-2}$ , increased from 9.2 to 11.5  $t\ ha^{-1}$ , and tiller mortality rate decreased from 0.7 to 0 (not shown), if all primary tillers were systematically removed from the plant as soon as they appeared. Decrease in rice tiller mortality rate, from 0.33 to 0.24, by increasing water depth at mid-tillering, however, did not affect grain yield.

- Decrease in tiller mortality rate from 0.33 to 0.24
- Similar productive tiller number
- Similar rate of tiller emergence

Measured grain yield was 6.9 and 6.6  $t\ ha^{-1}$

## Discussion

Potential dynamics in tiller emergence were similar for both species as long as it is observed at the mother tiller level. Control in tiller production with growing conditions, however, appeared distinct for both species. Cessation in tiller emergence in sorghum seemed to be controlled by local light conditions before any trophic limitation occurred in the plant, whereas that in rice tiller production appeared to be the result of the trophic status of the plant. These behaviors would be in agreement with observation that the tiller mortality rate did affect final grain yield in sorghum, while it did not in rice. Additional studies concerning carbohydrate remobilization from senescent organs in both species, in relation with the type of tillering response, should be set up.

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