Physiological response of oil palm progenies to drought applied at young vegetative stage

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Towards the adaptation of genetic material to specific drought

Classically, water deficit is characterized by timing, duration and intensity. Plant material from a given genetic origin can hardly be adapted to all possible combinations of these three components. There is a need to quantify the dynamic response of oil palm to progressive soil water deficit in order to identify adaptative traits in relation with stress duration and intensity. An experiment in growth chamber has been conducted in Cirad at Montpellier to study the physiological response of 4 month oil palms from 3 progenies and explore their genetic diversity, in the framework of an international project on G x E interactions in oil palm (CIGE project).

Regulation of leaf area

Development rate and leaf expansion

The plant leaf area is driven by the rates of leaf appearence and leaf expansion. With FTSW (Fraction of Transpirable Soil Water) lowering from 0.8 to 0.2, no change in appearence rate has been observed (Fig. 1) while leaf expansion rate decreases in all progenies very early in the dry-down process, with FTSW up to 0.6 (Fig 2) This disconnection between development and growth is confirmed by the spear accumulation observed in adult oil palm plantations with drought.

Young oil palms in growth chamber at Cirad, 2015

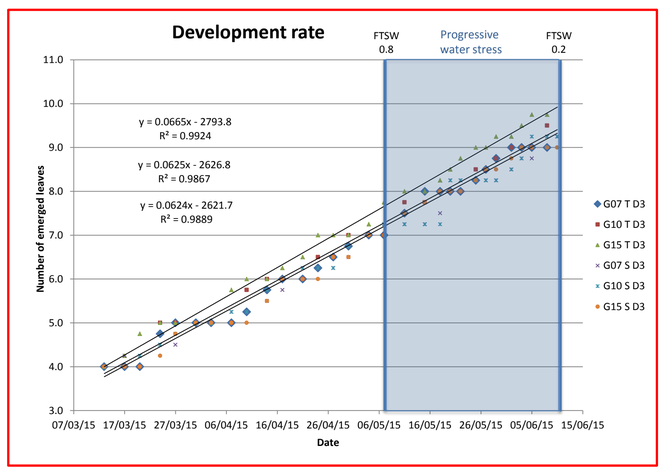

Figure 1: Leaf appearence rate in the 3 progenies

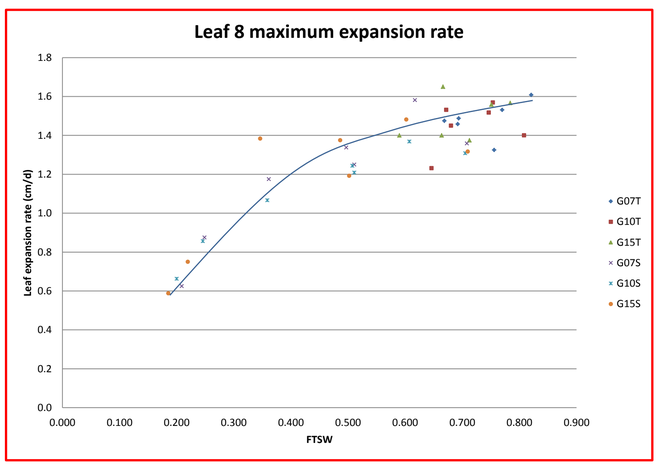

Figure 2:Leaf expansion rate in the 3 progenies

Regulation of carbon assimilation

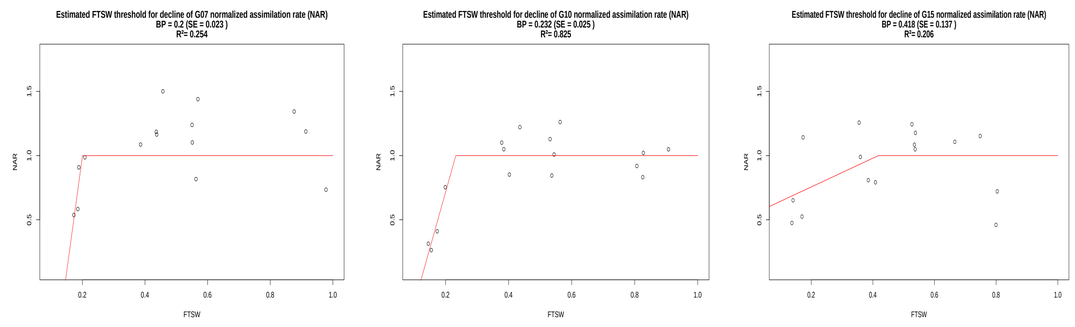

Figure 3 Normalized assimilation rate in the 3 progenies

Levels of photosynthesis are not different within progenies on irrigated treatment (not shown here). With decreasing FTSW, progenies respond differentially : in G07 and G10 there is a maintenance of the assimilation rate down to FTSW =0.2, followed by a strong reduction ; on the other side, the lowering in G 15 starts sooner, for FTSW around 0.4, and is more progressive.

Discussion and interpretation

Physiological mechanisms sensitivity and its consequence

With the application of a progressive water deficit, the study highlights that physiological processes have distinct critical thresholds (Fig. 4) : While development rate is unaffected even with severe water stress, expansion rate is slowed down at a slight stress and photosynthesis at a moderate one. In the interval when carbon assimilation is maintained and organ expansion reduced, assimilates are directed to storage compartments, mainly stem and leafstalks. This could also be the time domain for osmotic adjustment in leaves, that needs to be better explored.

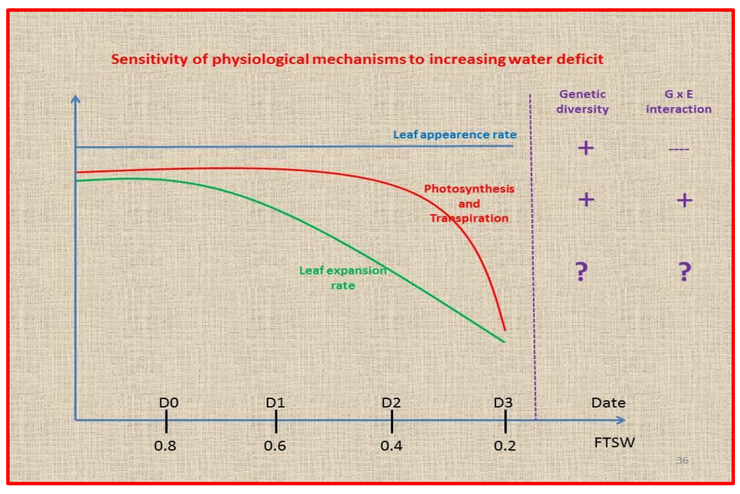

Figure 4 : Sensitivity of physiological mechanisms to drought response

Genetic differences

Beyond common responses to drought, genetic differences are pointed by the study, for development rate and photosynthesis, as well as interaction effects. More experiment is needed to explore genetic response diversity for expansion rate.

CONCLUSION

This study on young palms conducted in controlled conditions aimed at quantifying the physiological response of some progenies to progressive water stress. Genetic differences observed give new opportunities to breeding programs for drought adaptation.

REFERENCES

Ray JD, Sinclair TR. (1997) Stomatal closure of maize hybrids in response to drying soil. Crop Sci.37, 803-807

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