



Is light competition between trees and crops a limiting factor for agroforestry systems at high latitudes?

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Objectives

Farmers from Northern latitudes often disregard agroforestry on the believing that light is a limiting factor at Northern latitudes and that the competition for light by trees would prevent the crops to yield satisfactorily.

We used a simulation model to calculate the light availability for the crops at different latitudes. We assessed the impact of two tree densities (40 versus 84 trees/ha, 35 versus 17 m between tree lines) and two tree line orientations (North-South versus East-West).

Methodology

Hi-sAFe is a simulation model developed during the SAFE project [1, 2]. We simulated the same agroforestry stand at different latitudes using the same scene (soil description, walnut tree species, daily rainfall and temperature). Only the radiation was tuned to the latitude. Radiation was provided by the CliPick climate simulator [3]. The range of latitude explored varied from 38°N to 52°N.

We explored the light availability (Photosynthetically Active Radiation, PAR) for the intercrops at various times of the year, and the light heterogeneity within the cropped alley (Coefficient of Variation at the meter scale).

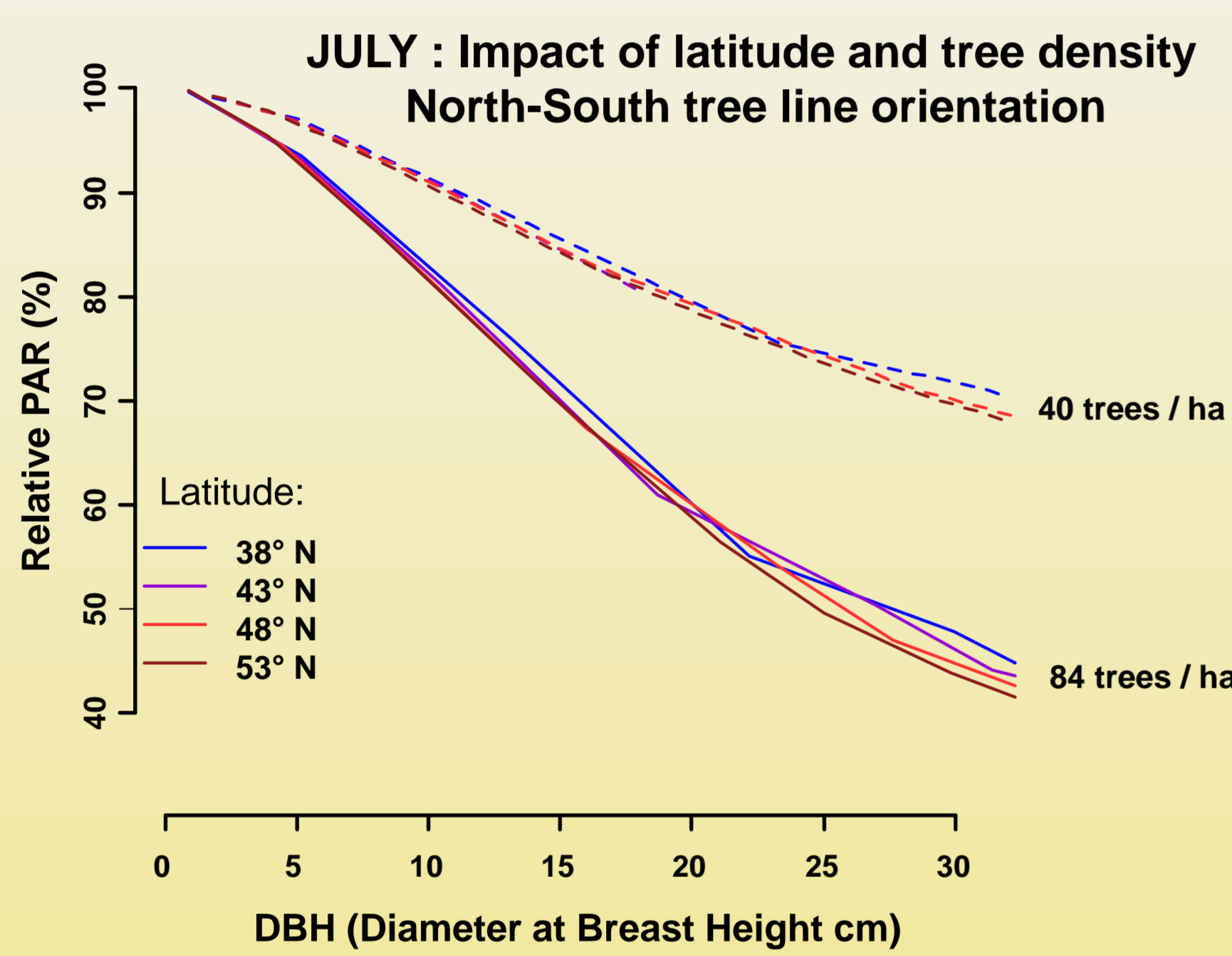


Irradiance of crops

Tree density impacts much more the relative irradiance than latitude.

Tree row orientation impacts also more irradiance than latitude

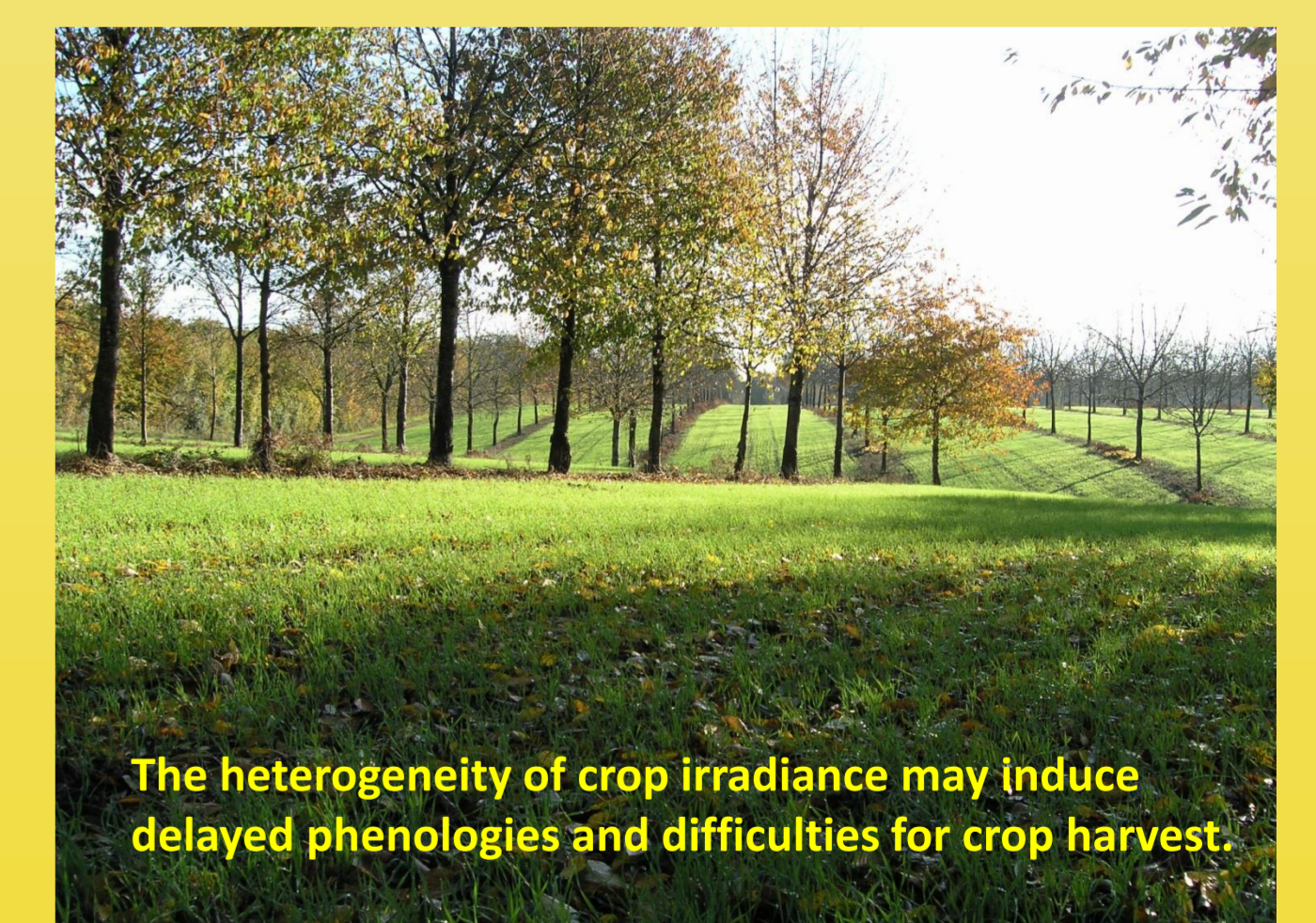
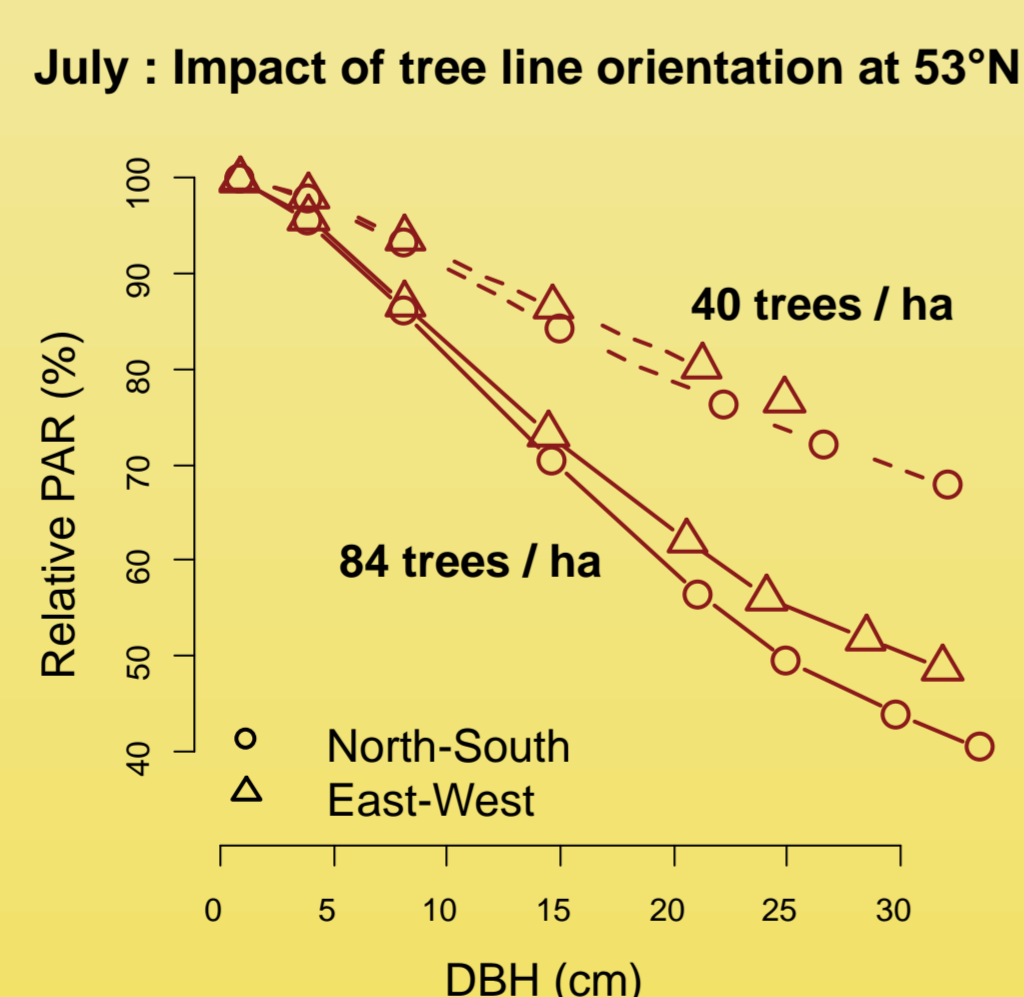
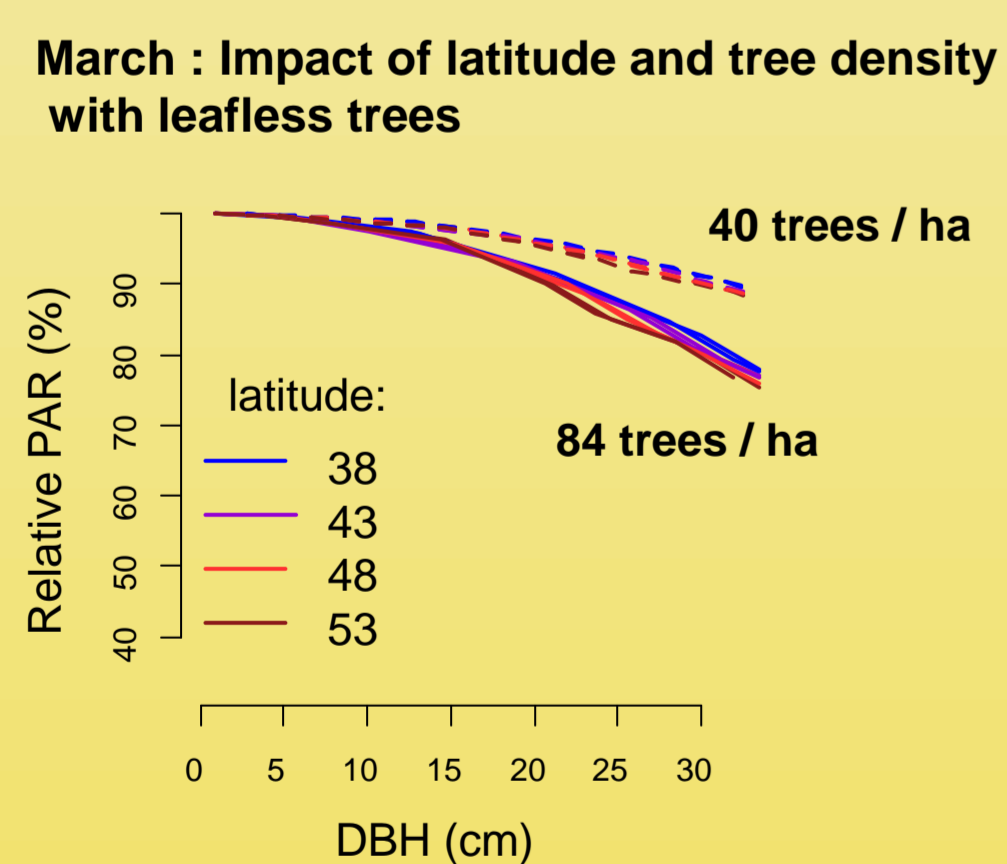
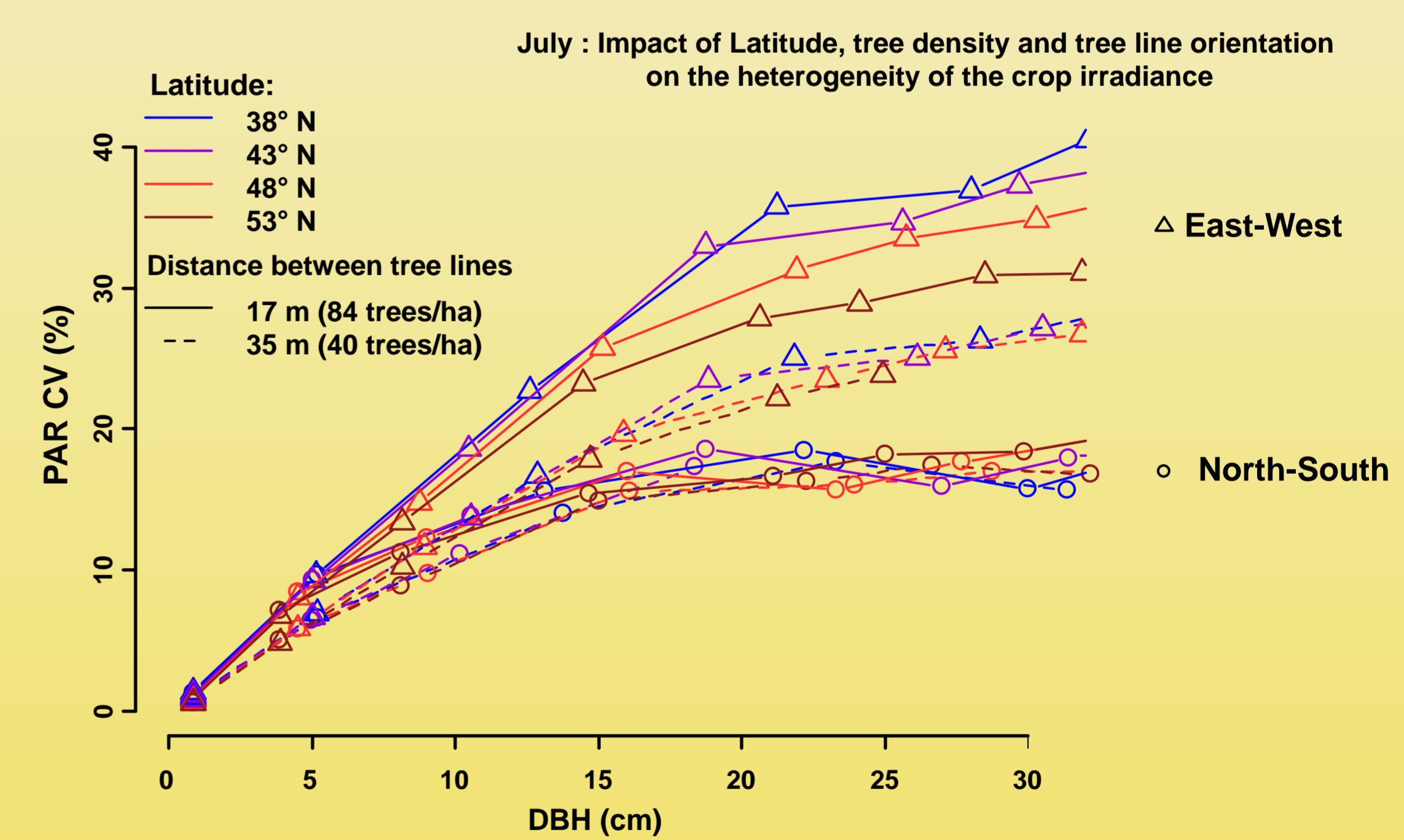
North-South orientation results in less radiation available for the crops at all latitudes.
Relative irradiance of crops is higher at 53° N with E-W lines than at any latitude with N-S lines.



Heterogeneity of light

-Light availability is homogeneous with North-South tree lines at all latitudes.

-East-West tree lines induce high heterogeneity of light, especially at low latitudes and with close tree lines.



Conclusion

- Agroforestry is possible at Northern latitudes : relative irradiance is very similar at all latitudes.
- East-West tree lines allow for more radiation to the crop but induce high heterogeneity. North-South tree lines are recommended.
- At Northern latitudes, trees grow slower, and are expected to be smaller at harvest. Therefore, the tree impact on the crops should probably not be asserted with equal size trees.
- The fraction of light received by the crops in the alleys is very similar at all latitudes and for all seasons. However, due to a reduced absolute radiation availability at Northern latitudes, the same relative light loss may have different impacts on the crops. Crop shade tolerance must be taken into account, and may be different for northern and southern crops.



References

- [1] Dupraz et al, 2005. SAFE project Report : <http://www.montpellier.inra.fr/safe/english/results/final-report/SAFE%20Final%20Synthesis%20Report.pdf>
- [2] Talbot 2011, Ph. D. thesis : <http://tel.archives-ouvertes.fr/tel-00664530>
- [3] <http://home.isa.utl.pt/~joaopalma/projects/agforward/clipick/>