Gembloux Agro-Bio Tech
Université de Liège

Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège – vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Madame Sidonie ARTRU,

Titulaire d'un diplôme de master sciences, technologies, santé, mention biologie, géoscience, agroressources et environnement, spécialité écologie fonctionnelle et développement durable

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 6 juin 2017, à 15 heures précises (personne ne sera admis après cette heure),

en l'auditorium de Sylviculture (bât. 9),

Passage des Déportés, 2 à 5030 **GEMBLOUX**.

Cette dissertation originale a pour titre :

« Impact of spatio-temporal shade on crop growth and productivity, perspectives for temperate agroforestry ».

Le jury est composé comme suit :

Président : Prof. P. LEJEUNE, Président du Département BIOSE,
Membres : Prof. S. GARRE (Promoteur), Dr L. LASSOIS (Copromoteur), Prof. B. BODSON, Prof. B. REUBENS (ILVO), Prof. C. DUPRAZ (INRA), M. G. LIGOT, M. B. DUMONT.

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Abstract

Nowadays, silvoarable agroforestry systems are receiving a renewed interest in Europe as a land use system combining production of commodities with the delivery of a range of services such as environmental protection. Despite the potential of this practice, it remains only rarely implemented in North-western Europe. One of the stumbling blocks to the adoption of silvoarable agroforestry systems is the lack of quantitative knowledge on the short- and long term performance of different crops when competing for resources with trees. Facing the large panel of possible tree-crop arrangements and the occurrence of multiple feedback loops between variables, it remains difficult to obtain a clear overview for the overall system functioning. In this thesis, we simplify the complexity by focusing our research questions on the resource light, based on the assumption that in the Belgian climatic conditions light is likely to be the predominant constraint for the understory crops in a silvoarable agroforestry system. Our research approach aimed at getting better insights into growth mechanisms and final yield of shaded winter wheat and sugar beet crops, as essential crops in one of the conventional rotation systems adopted in Belgium.

We address these questions using an artificial shade system developed in order to reproduce the effect of the heterogeneous spatio-temporal pattern of light observed under late-flushing trees in an agroforestry system. This allowed us to isolate the influence of the light environment from competition effects for water and nutrients. Winter wheat responded to the late application of continuous and periodeic shade treatments by a significant decrease of grain yield, which was partly compensated by an increase in the grain protein content. When shaded, sugar beet responded through morphological adaptations of the aboveground part of the plant and a decrease on the final root dry matter and sugar yield. In general, the magnitude of final yield repercussion varied with the level and the period of shade application.

Furthermore, an arable plot bordered by a poplar tree row was selected to evaluate the effects of real trees on winter wheat. The reduction of the final grain yield follows a gradient from tree to the center of the field. Even though in this setting other interactions than light competition may occur and affect yield, the maximum yield reduction observed under the tree never reached the level of decreased observed under the continuous shade treatment simulated by the artificial shade set up.

The experimental approach on winter wheat was complemented by a modelling study in which we evaluate the ability of the STICS crop model to simulate crops growing under dynamic shade. Overall, the model accurately reproduces the total aboveground dry matter dynamics under the continuous shade treatment, but was not sensitive enough to simulate the reduction observed under the periodic shade treatment. The results highlight the limits of the STICS model to simulate the final grain yield under the shade treatments.

Finally, we zoom out from our specific focus on light competition to the place of agroforestry practices in a broader reflection of agricultural transition. We define agroecology as a conceptual framework to develop sustainable and profitable agroforestry systems in Europe through reflection on the agricultural practices, food systems and research methodologies and situate the place agroforestry systems may have within this framework.