Impact of **biochar** soil incorporation on the growth of **grapevine** cuttings

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Introduction

Biochar is a carbon-rich amendment produced by biomass pyrolysis. It can enhance carbon sequestration, water-holding capacity, and soil physicochemical and microbial properties [1, 2, 3, 4, 5]. Biochar **properties depend strongly on biomass source and pyrolysis conditions** [1]. Its effects on soils and plants also depend on soil type, climate, plant material, and time [1, 3]. Consequently, **crop responses are highly context-dependent** [1, 4]. In this study, we assess the effects of a slow-pyrolysis biochar derived from local Walloon woody biomass on the early development of *Vitis vinifera* (cv. Pinot noir) cuttings (Fig.1a). **Early vigor is critical during vine establishment**, particularly under increasing drought stress, which disproportionately affects young vines and other young perrenial crops with limited root systems [4].

Methods

Experimental setup

- **Greenhouse** experiment
- **Loamy agricultural soil** (Ath region, Belgium)
- **Biochar** incorporation : 1.5 → 54 g·kg^{-1} soil
- **196 grapevine cuttings** (c.v. Pinot noir)
- **49 experimental units** (4 plants/unit)
- **Latin square design** allowing an analysis of variance (ANOVA) at a 5% significance level

Measurements :

- ✓ **Growth** : shoot length, aboveground biomass, and root biomass (Fig.1b-c)
- ✓ **Physiological indicators** : chlorophyll content and nitrogen balance index (NBI)
- ✓ **Soil analysis** : soil water holding capacity (WHC) on oven-dried samples (105°C, 24h)

Figure 1 : Illustrations of greenhouse experiment. (a) Visual aspect of the biochar used in this experiment before its soil incorporation. (b) Measurement of grapevine shoot development during the experiment. (c) Recovering of root and shoot biomass at the end of the experiment.

Results

- **Growth response** : significant increase in shoot growth (Fig.2a), aboveground and root biomass (Fig.2b) observed from ≥ 9 g·kg^{-1} biochar
- **Plant physiology** : no change in chlorophyll content (Fig.2c) and nitrogen balance index (NBI)
- **Soil properties** : significant improvement of water holding capacity (WHC), from 19.8% to 23.2% at the highest incorporation rate (Fig.2d)
- **Key insights : clear dose-response relationship, and identification of a minimum effective dose.**

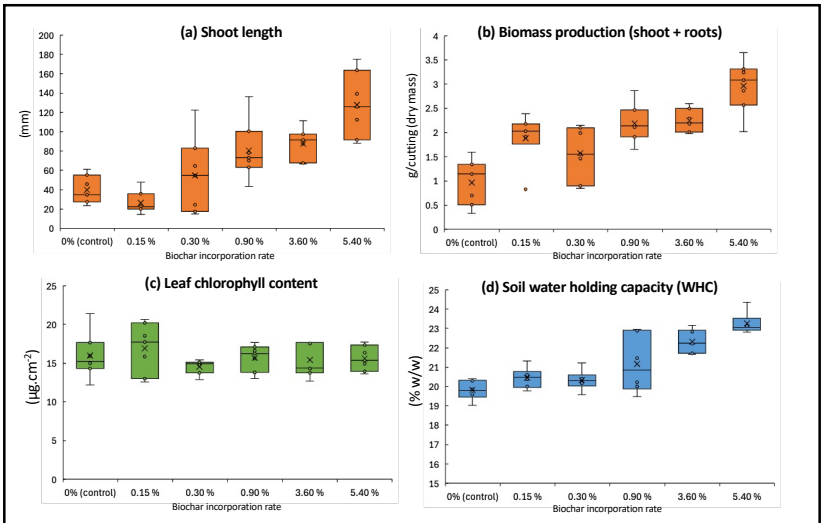

Figure 2 : Effects of biochar incorporation rate on grapevine cutting growth, physiological status, and soil characteristics. (a) Shoot length and (b) biomass measurements were obtained 56 days after bud break. (c) Leaf chlorophyll content measurements were performed 49 days after bud break, with Dualex® device, on the most developped leaves. (d) Soil water holding capacity was obtained on soils 3 months after incoporating biochar.

Conclusions

Main outcomes :
Our findings indicate that this locally produced biochar can enhance root and shoot development of grapevine cuttings without affecting their photosynthetic activity.

Likely mechanism :
The improved soil water retention is probably the key factor, particularly given our experimental conditions with a small soil volume available for root development (0.5 L) and the dry greenhouse conditions.

Implications :
Such effects are promising for vineyard establishment, during which young vines might cope with episodes of water stress, while root extension is not fully achieved. By enhancing early vigor and root system expansion of grafted plants, biochar incorporation may serve as a valuable strategy to improve resilience and successful establishment in viticultural systems.

Perspectives

Further work shoud **more deeply characterize** the effects of this biochar on physicochemical and microbiological properties of soils. **Field trials under real vineyard conditions** (i.e. in planting holes, or urban vineyards with constrained soil volumes) are essential to **better assess short- and long-term agronomic and environnemental outcomes**.

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References

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