**Supplementary Information**

Asymmetric neighbourhood computation

Competition for resources is considered a main limiting factor for plant growth[1], and because plants, unlike animals, are unable to change their physical location, their resource acquisition depends on their local environment, including resource availability, plant size and the distance and size of neighbours with whom they compete[2,3]. This has driven the development of position-dependent competition indices[2]. The larger and closer a given plant's neighbours are, the stronger the competition the plant experiences, but this competition pressure can be reduced by the target plant's size. For example, competition is thought to be symmetrical if within a given group of trees all the neighbours are located at similar distances and are of a similar size (i.e. all neighbours possess similar chances to access resources). The opposite occurs for plants with contrasting size distributions, where bigger plants have a disproportionately larger effect on competition and resource acquisition1 over smaller neighbours. This concept has stimulated the development of several methods to measure competition and study its effect on forest community dynamics[2]. A commonly used competition index is that developed by Hegyi[4], defined as

$$CI_{ij} = \frac{\left(\frac{D_{130_i}}{D_{130_j}}\right)}{dist_{i-j}},$$

where $CI_{ij}$ represents the competition index between a target $tree_i$ and a given $neighbour_j$. $D_{130_j}$ is the stem diameter $neighbour_j$, whereas $dist_{i-j}$ is the distance between the $tree_i$ and its $neighbour_j$. This means that the larger $D_{130_i}$ is relative to $D_{130_j}$, the smaller $CI_{ij}$ becomes, and the cumulative competition ($CI$) for a $tree_i$ (the sum of competition values computed for each neighbour of $tree_i$: $CI = \sum_j CI_{ij}$) decreases as the stem diameters of target trees become wider (Fig. S1A). Then, $CI$ is a measure of competition autocorrelated to tree size; however, when assessing the effect of $CI$ on tree allometry, statistical assumptions of independence between variables are violated, so no conclusions can be drawn as to the potential effect of neighbourhood interactions on final tree height irrespective of grafting (Fig. S1B). Thus, the question remains open as to whether trees are grafted because they have wider stem diameters, or they have wider stem diameters due to being grafted (Fig. S1B).

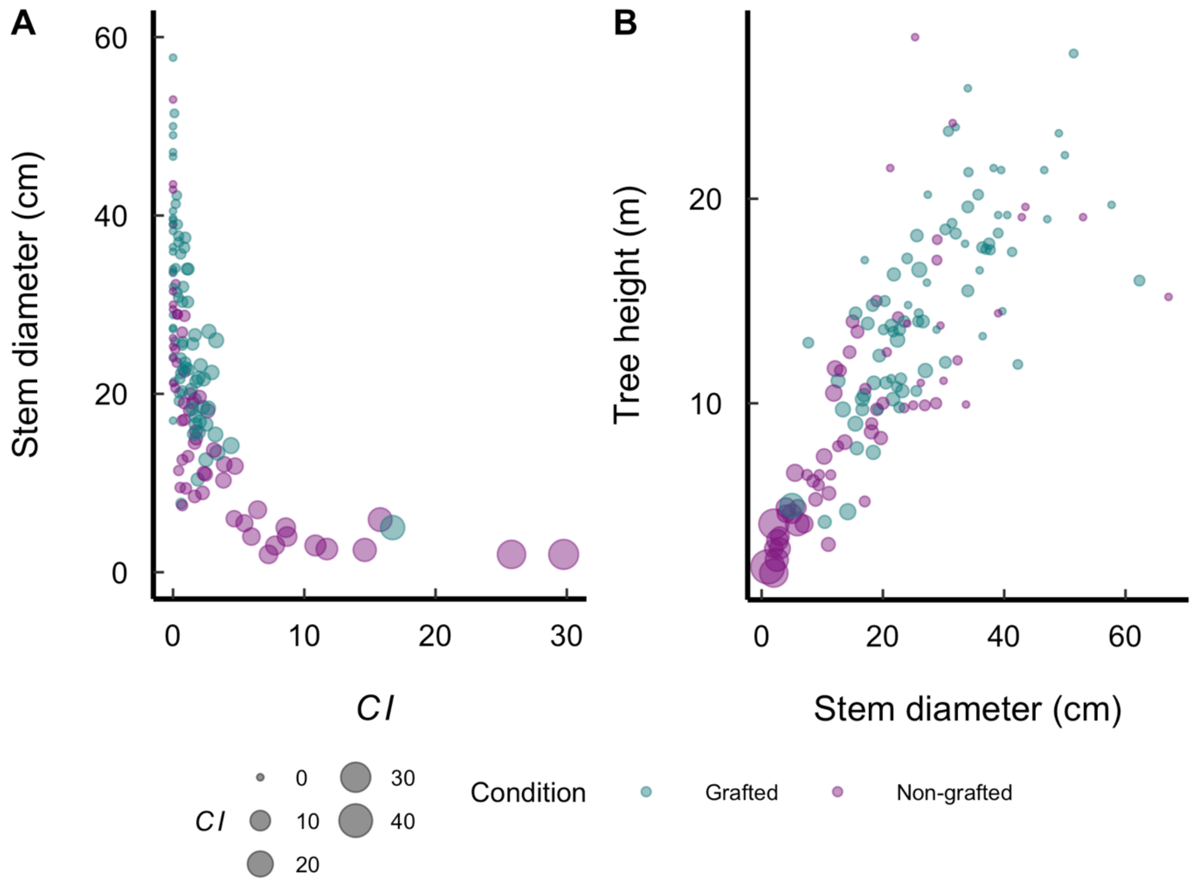


Figure S1. **A** Relationship between competition index ($CI$) and stem diameter for grafted (blue) and non-grafted trees (purple) with increasing $CI$ (point size) showing that higher $CI$ values correspond to smaller stem diameters ($p < 0.001$). **B** Relationship between tree stem diameter and height showing that the $CI$ is reduced as stem diameters increase regardless of the grafting condition.

To deal with the autocorrelation effects of the Hegyi index, we adapted an approach to estimate asymmetric neighbourhoods as an estimate of the competitive pressure of a target $tree_i$ based on the position and size of its neighbours5,[6] defined by the following vector:

$$v = \sum_j \frac{D_{130_j}}{\left|S_i - S_j\right|^2} \left(S_i - S_j\right),$$

where $v$ represents the vector of the neighbourhood asymmetry. The sum runs over the neighbours ($j$) of the target $tree_i$. $D_{130_j}$ is the diameter of each neighbour, whereas $\left|S_i — \mathrm{S_j}\right|^2$ denotes the squared distance between the stem position (S) of neighbour j and the stem position S of target $tree_i$, and ($S_i$— $\mathrm{S_j}$) expresses the vector between the positions of trees $j$ and $i$. This approach was originally developed to understand the plastic responses of root systems to neighbours and was further applied to explore tree-crown plasticity[5-8]. It is useful for determining the relationship between neighbour sizes and grafting status as it does not assume interactions between the target tree and its neighbours. As we are only interested in the magnitude of the neighbourhood asymmetry, not the direction, we used $|v|$ (the magnitude of vector $v$) and related it to each tree's stem diameter and grafting status, where for any given neighbourhood asymmetry size, there was an array of stem diameters (Fig. 2A) and an adequate exploration of tree height as a response to stem diameter and neighbourhood attributes could be assessed (Fig. S2B).

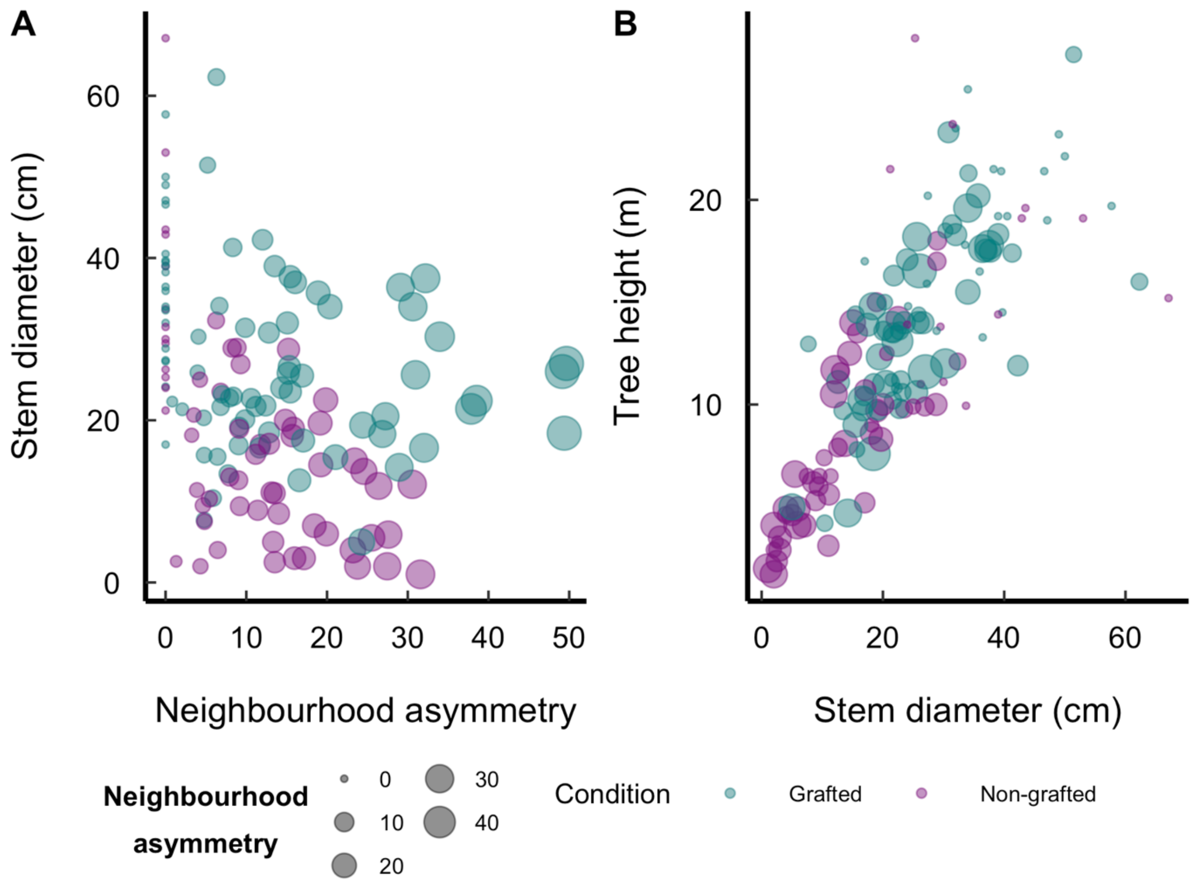


Figure S2. A Distribution of the stem diameters of grafted (blue) and non-grafted (purple) trees along a neighbourhood asymmetry index (point size) showing that grafted trees have wider stem diameters regardless of the pressure of neighbours. Size of asymmetric neighbourhoods shown by point size. B Relationship between the tree height and stem diameter of grafted and non-grafted trees showing that highly asymmetric neighbourhoods can be found over the full range of stem diameters.

As shown in Fig. S2B, a tree of any given stem diameter can have high or low asymmetrical neighbourhoods, while a large proportion of non-grafted trees belong to stem diameter classes below 15 cm (Fig. S3).

References


1. Weiner, J. & Damgaard, C. Size-asymmetric competition and size-asymmetric growth in a spatially explicit zone-of-influence model of plant competition. *Ecol. Res.* **21**, 707–712 (2006).
2. Pretzsch, H. *Forest dynamics growth and yield*. *From Measurement to Model* **1**, (Springer-Verlag, 2009).
3. Berger, U., Piou, C., Schiffers, K. & Grimm, V. Competition among plants: concepts, individual-based modelling approaches, and a proposal for a future research strategy. *Perspect. Plant Ecol. Evol. Syst.* **9**, 121–135 (2008).
4. Hegyi, F. A simulation model for managing Jack-pine stands. in *Growth Models for Tree and Stand Simulation* (ed. Fries, J.) 74–90 (Royal College of Forestry, 1974).
5. Vovides, A. G. *et al.* Change in drivers of mangrove crown displacement along a salinity stress gradient. *Funct. Ecol.* **32**, 2753–2765 (2018).
6. Brisson, J. Neighborhood competition and crown asymmetry in *Acer saccharum*. *Can. J. For. Res.* **31**, 2151–2159 (2001).
7. Brisson, J. & Reynolds, J. F. The effect of neighbors on root distribution in a Creosotebush (*Larrea Tridentata*) Population. *Ecology* **75**, 1693–1702 (1994).
8. Aakala, T., Shimatani, K., Abe, T., Kubota, Y. & Kuuluvainen, T. Crown asymmetry in high latitude forests: Disentangling the directional effects of tree competition and solar radiation. *Oikos* **125**, 1035–1043 (2016).