Intrinsic determinants of mango tree growth and reproduction: Consequences on functional-structural modeling

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Mango trees are characterized by alternate bearing and phenological asynchronisms. We hypothesize that this behavior ensues from a complex interplay between reproductive and vegetative development. These interplays result from the action of some **intrinsic factors** and influence tree development in both a quantitative and temporal way. A functional-structural model of mango tree development and production must account for these factors and their effects.

The objective of this study was to identify the intrinsic factors that influence the vegetative and reproductive development of mango trees, with specific focus on architectural factors.

Materials and Methods

The development of mango tree was described at the **growth unit (GU) level**. Mango trees have rhythmic growth. A GU that developed during the previous growing season produces one to several GUs. These GUs can themselves grow and branch in this way during the growing season and produce successive growth levels (Fig. 1). Flowering appears at the apex of the GUs after a resting period. Only some inflorescences set fruits; the others die.

An exhaustive description of vegetative and reproductive growth was carried out in Reunion Island on five trees of four mango cultivars during two phenological cycles. Each year, the fruits of two trees per cultivar were thinned at fruit set in order to have trees with or without fruit load. Each new GU was characterized by its **position** (apical vs lateral), its **growth level** (1st, 2nd, etc.), its **date of burst**, and its **type** (vegetative, flowering or fruiting). For inflorescences, the date of burst, fruit setting and the number of fruits were recorded.

Vegetative (Fig. 2) and reproductive growths were broken down into elementary processes. An appropriate categorical or count distribution was selected for each process. **Generalized linear models** were used to test the effects of quantitative, qualitative or temporal factors related either to the parent GU or to the whole-tree on each elementary process.

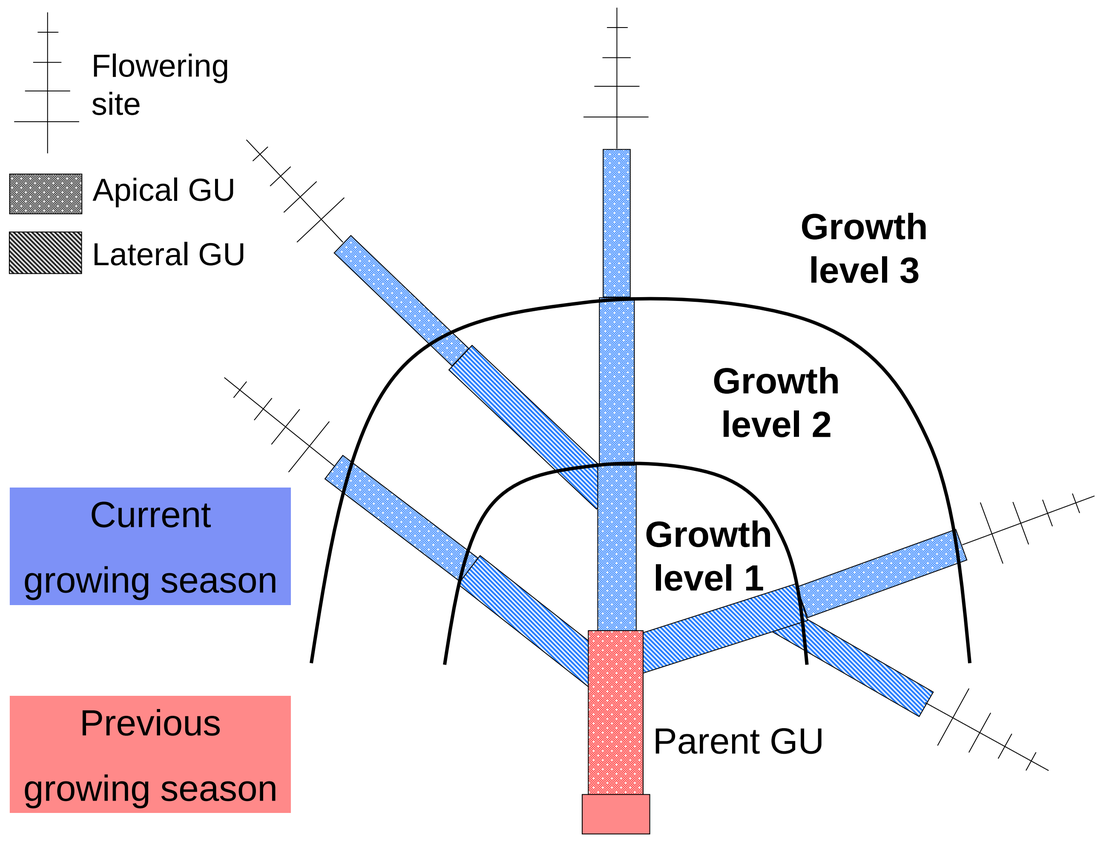

Fig. 1: Growth units produced by a parent GU during a growing season

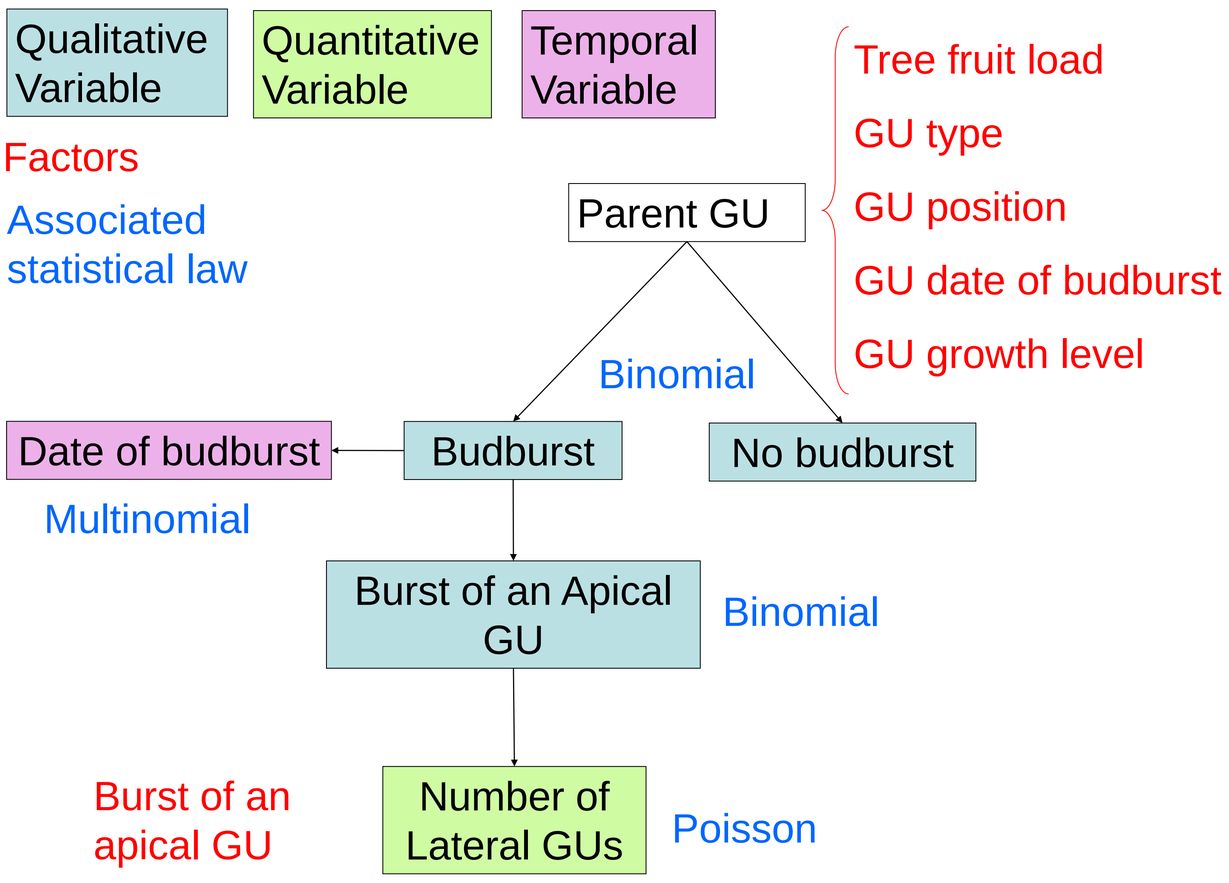

Fig. 2: Elementary processes of vegetative growth

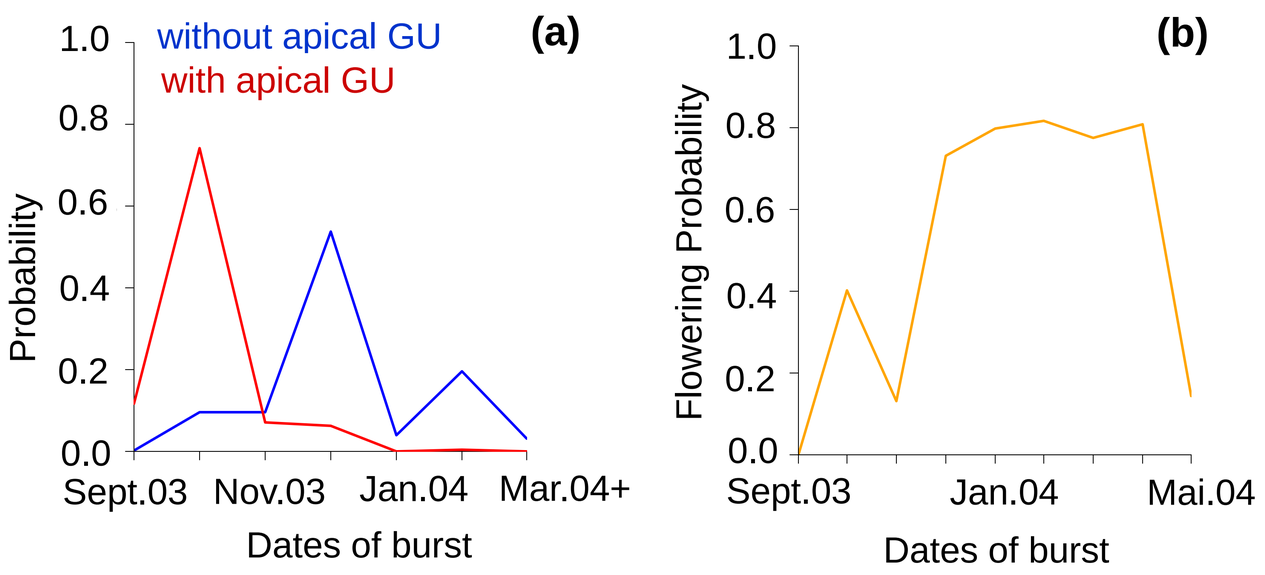

Fig. 3: a) The burst of an apical daughter GU affects the date of burst of the parent GU. b) Occurrence of flowering as a function of the GU date of burst. Cultivar "Cogshall", 2004

Results and Discussion

Only some results are presented, highlighting three main trends:

- **Architectural factors influence mango tree growth in a quantitative way.** The position of the parent GU influenced the number of lateral GUs: an apical parent GU produced more lateral GUs than a lateral parent GU (Table 1).
- **Architectural factors influence mango tree growth in a temporal way, i.e., tree phenology.** Parent GUs that produced an apical daughter GU generally burst earlier than GUs without an apical daughter GU (Fig. 3a).
- **There are complex qualitative, quantitative and temporal interplays between vegetative and reproductive development.** Flowering probability depended on the date of burst of the parent GU (Fig. 3b). In contrast, the occurrence of budburst depended on the type of the parent GU and on the tree fruit load (Table 1).

Table 1: Significant factors related to the tree and the parent GU that affect vegetative and reproductive growth (set-up of the first growth level and reproduction, cultivar "Cogshall", 2004)

Process (Fig. 2)	Significant factors
Occurrence of budburst	GU type, GU position, Tree fruit load
Burst of an apical GU	GU type
Number of lateral GUs	GU position
Date of budburst	Burst of an apical GU (Fig. 3a), GU type
Occurrence of flowering	GU date of budburst (Fig. 3b), GU growth level, GU position, grand-parent GU position
Occurrence of fruiting	GU position, GU growth level

Conclusion

This statistical modeling approach enabled us to identify and characterize the intrinsic factors that must be integrated into a functional-structural model of mango tree development and phenology. This model will be used to predict yield or periods when mango trees are particularly sensitive to pests.