



Vegetative growth and development of the mango tree canopy Understanding and practical applications

Frédéric Normand

CIRAD, UPR HortSys, 97455 Saint-Pierre, Réunion Island, France frederic.normand@cirad.fr

XIII International Mango Symposium, Malaga, Spain, September 29 - October 3, 2023

Outline

1-Introduction

- 2- The growth unit: the basic unit of mango vegetative growth
- 3- Vegetative growth results from complex interactions
- 4- Interactions between vegetative growth and reproduction
- 5- Practical applications
- 6- Conclusion

1- Introduction

Why dealing with vegetative growth when we are interested in fruit production?



Builds the tree architecture

Determines tree dimensions \rightarrow potential fruit production \rightarrow ease of cultivation practices

Function of support \rightarrow leaves (photosynthesis) \rightarrow flowers and fruits \rightarrow tree structure

Function of transport

- \rightarrow water, nutrients, hormones
- \rightarrow carbohydrate
- \rightarrow signalling molecules

Function of reserves \rightarrow starch

 \rightarrow nitrogen

1- Introduction

Why dealing with vegetative growth when we are interested in fruit production?



But excessive growth may be detrimental to economic fruit production

Hence the interest in better understanding mango vegetative growth and its determinants in order to maintain

- \rightarrow reasonable tree dimensions
- \rightarrow a balance between vegetative growth and fruit production
- \rightarrow more sustainable mango production

2- The growth unit: the basic unit of mango vegetative growth

Rhythmic vegetative growth



The new structure is called a growth unit

Different names are used for the growth unit: shoot, flush, branch, intercalary unit.

The woody structure of the mango tree is formed by succession and branching of growth units



All pictures Author: F. Normand

2- The growth unit: the basic unit of mango vegetative growth

Description of growth units



Morphology

- Stem length
- Stem mass
- Basal diameter
- Number of leaves
- Total leaf area
- Individual leaf area
- Leaves mass

Age

• Date of burst

Topology

 Position with respect to the previous growth unit (apical / lateral)

Origin

- Sequential
- Reiteration



Author: F. Normand

- Author: F. Normand
- \rightarrow Several sets of thematic variables to characterize a growth unit
- → They affect the ability of the growth unit to grow vegetatively or to flower and set fruit

Fate (or activity)

- Quiescent
- Flowering
- Fruiting
- Vegetative



Effects of environmental factors



1- <u>Temperature</u>

- effects on rhythm of vegetative growth

Rhythm of vegetative growth increases with temperature, with a marked effect of the cultivar (Whiley et al., 1989)

Stem and leaves growth rate increases with temperature (Dambreville et al., 2013a)



Effects of environmental factors



1- <u>Temperature</u>

- effects on growth unit morphology

Temperature has a positive effect on growth unit stem length, number of leaves and leaf area (Whiley et al., 1989)

The positive effect of temperature on growth unit morphology occurs from

morphogenesis at the bud stage,

to

the first stages of leaf development (Dambreville et al., 2013a; Legris, 2023).







- branching density (Normand et al., 2009b; Dambreville Kensington Pride (Smith et al., 2008) et al., 2013b)
- rhythm of vegetative growth (Whiley et al., 1989)
- the rootstock affects
 - overall tree growth (cf Galan Sauco, 2019 for references)



Effects of endogenous factors



- 2- Effect of topology on growth unit morphology
 - apical growth units are longer, thicker and more leafy than lateral growth units (Normand et al., 2009a)







- 3- Growth units have short- to long-term effects on vegetative growth
 - short-term effect: during the annual period of vegetative growth

the topology and the date of burst of a growth unit affect its vegetative growth (occurrence, date, number new growth units)

apical > lateral (Normand et al., 2009a; Dambreville et al., 2013b)

early > late (Dambreville et al., 2013b)

- long-term effect: from one year to the following one

the topology and the date of burst of the terminal growth unit affect vegetative growth during the following year (occurrence, date, number new growth units) (Issarakraisila et al., 1997; Dambreville et al., 2013b)

Effects of cultivation practices

1- Pruning

- pruning is a trigger of bud burst





- **Pruning severity**: distance between the axis apex and the pruning cut
- The more severe the pruning, the higher the probability of bud burst (Persello et al., 2019).
- Pruning intensity: ratio between the biomass removed and the canopy volume before pruning
- The more intense the pruning, the higher the probability of bud burst, even on unpruned growth units (Persello et al., 2019). ¹⁴





1- Pruning

- tree response to pruning depends on various factors
 - pruning intensity and severity (Persello et al., 2019)
 - period of pruning within the growing cycle (Oosthuyse, 1995; Fivaz et al., 1997; Davenport, 2006; Wilkie et al., 2008; Hermoso González et al., 2018)
 - plant material (Oosthuyse, 1997; Yeshitela et al., 2005)
 - characteristics of pruned growth units (Oosthuyse, 1992; Persello et al., 2019)
- tree response to pruning occurs at different scales
 - pruned and unpruned growth units: occurrence, dynamics of bud burst, number and morphology of new growth units (Oosthuyse, 1994; Yeshitela et al., 2005; Persello et al., 2019)
 - tree canopy size, morphology and foliage density (Oosthuyse, 1992, 1994; Oosthuyse and Jacobs, 1995; Fivaz and Stassen, 1997)

Effects of cultivation practices



2- Tree training

- canopy training affects vegetative growth, in interaction with pruning, plant material and canopy shape (Fivaz and Stassen, 1996; Campbell and Wasielewski, 2000; Crane et al., 2009; Bally and Ibell, 2015; Ibell et al., 2018)

3- Fertilization, irrigation

- Adequate fertilization and irrigation favor vegetative growth

- **1-** <u>At the terminal growth unit scale</u>: vegetative growth \rightarrow reproduction
 - several growth units characteristics affect flowering and fruit set
 - topology : apical > lateral (Normand et al., 2009a; Dambreville et al., 2013b)
 - diameter (Normand et al., 2009a)
 - age (Chacko, 1986; Scholefield et al., 1986; Davenport, 2009; Dambreville et al., 2013b)

1- <u>At the terminal growth unit scale</u>: reproduction \rightarrow vegetative growth

- the flowering/fruiting fate of a terminal growth unit affects negatively subsequent vegetative growth
 - reduced probability of bud burst (Issarakraisila et al., 1991; Dambreville et al., 2013b; Capelli et al., 2016)
- delayed bud burst (Dambreville et al., 2013b; Ramirez et al., 2014)
- \rightarrow reduced vegetative growth after harvest (Capelli et al., 2016)
- negative effects related to hormones and carbohydrates (Capelli et al., 2021)

- **2-** <u>At the tree scale</u>: vegetative growth \rightarrow reproduction
 - trees larger and/or with higher number of terminal growth units
 - = larger fruit production potential (Oosthuyse and Jacobs, 1995; Davenport, 2006)
 - but up to a certain tree size
 - it depends on the cultivar (Oosthuyse and Jacobs, 1995; Normand et al., 2017)



(Oosthuyse and Jacobs, 1995)

2- <u>At the tree scale</u>: reproduction \rightarrow vegetative growth

- heavy fruit load delays and reduces subsequent vegetative growth (Scholefield et al., 1986; Issarakraisila et al., 1997; Shaban, 2009; Dambreville et al., 2013b; Capelli et al., 2016; Normand et al., 2016)
- this effect is cultivar-dependent (Capelli et al., 2016; Normand et al., 2016)



5- Practical applications

1- Improvement of cultivation practices

- canopy management: pruning and training
- irrigation and fertilization program
 - \rightarrow no unique strategy
 - → should consider several local factors: plant material, environmental conditions, tree age, planting density

- modelling can provide valuable support (cf Isabelle Grechi's presentation)



5- Practical applications

2- Development and improvement of research practices

- develop research on vegetative growth and its interactions with reproduction, in relation to environmental conditions and cultivation practices
 → two scales: terminal growth unit, whole tree
- understand the processes underlying the observed relationships/events
- take vegetative growth into account in our protocols
 - \rightarrow at the terminal growth unit scale
 - integrate growth units characteristics affecting flowering and fruiting in the experimental design, or consider them as covariates
 - \rightarrow at the tree scale

explore the relationship between fruit production and tree size as soon as you study a factor affecting vegetative growth ²²

- Basic element of vegetative growth = growth unit
- Growth unit appearance and morphology are affected by environmental conditions, endogenous factors and cultivation practices
- Main factors: plant material (cultivar and rootstock), pruning, training, temperature, light, water availability, growth unit topology, age and fate
- Close interactions between vegetative growth and reproduction
- Vegetative growth is of utmost importance for mango production and orchard management
- Vegetative growth should be better considered in research programs



Cofinancé par l'Union européenne



Thank you for your attention Muchas gracias por su atención





REGION REUNION www.regionreunion.com



département Réunion



This work was carried out as part of the CIRAD DPPs COSAQ 1 and SADUR 2 agronomical research programs funded by the European Regional Development Fund and the Conseil Régional de la Réunion, Author: F. Normand

cirac