Characterization of the tree length structure of the Nectarine tree before flowering by metric measurements in Sefrou, Morocco.

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Abstract. This study aims to describe the architecture of Nectarine fruit trees located in Sefrou region. This characterization concerned the length variation of all the tree structure before flowering by metric exhaustive and non-destructive measurements. The study conducted on Nectarine variety of Spring Bright, by measuring 10 trunk, 40 frames, 157 1st underframe, 280 2nd underframe, 361 3rd underframe, 308 4th underframe, 134 5th underframe and 1250 of mixed branches, that have been labelled and numbered. The characterization of the tree revealed the underlying logic of the plant's construction, The lengths, decrease from scaffold to 5th level under frame but it experiences a 357% increase in length ratio for the mixed branch due to its role as the primary fructification structure. This type of distribution is logic for the goblet training pruning program. The mean number of structure evolution was (scaffold) 4/(1st level) 4/(2nd level)1/3rd level 2/(mixt branch) 9 . The raw length data was not homogeneous probably due to the pruning effect, so they were grouped in three to four class to enhance the homogeneity. **Keywords**: Nectarine tree; Tree Architecture; Structure length; mixt branch.

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1. Introduction

The peach tree (Prunus persica) is one of the most extensively cultivated fruit trees globally. It encompasses an estimated area of 1.5 million hectares and generates an impressive total production of approximately 16.5 million tons per year [1]. In Morocco, the Peach-Nectarine is the third rosaceous specie planted after almond and apple [2]. Meknes-Fes region (Saïs) is the most important leading peach and nectarine producing area in the country, representing 16% of the total area of this specie [2]. It has a production of 82,000 tons/year and an area of about 8700 hectares in the 2019/2020 season [2].

One of the main problems of peach-nectarine producers is the yield estimation and the better understanding of the evolution and variation of the length of the principal structures can lead to develop an accurate yield prediction model. Indeed, the lengths and positions of frames, Sub frames and mixed branches of trees can affect the yield [3]. In addition, a direct relationship has been established between tree vigor and canopy volume [4] [5] [6]. However, canopy volume is difficult to measure, requiring the use of image analyzers that are expensive and time-consuming [7].

This model would then allow for early prediction of Peaches and nectarine yields and subsequently an early intervention to avoid problems in the chain. Indeed, the prediction of the harvest begins, first, with a perfect knowledge of the length of different components of architecture of this tree.

2. Material and Methods

To achieve the objective of this study, measurements are made in the Agricultural domain of Louata located in north estern of Morocco (33°54'21.8 "N 4°39'59.8 "W, Sefrou) (figure 1)

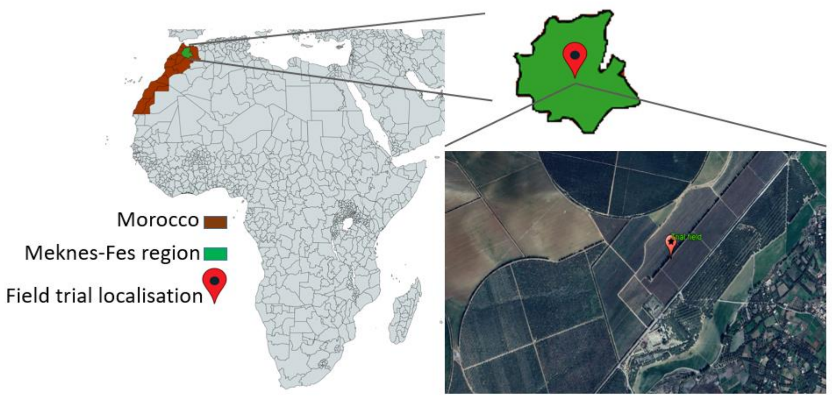

Fig. 1. field trial localization

The experiment was conducted on a homogeneous plot of Spring Bright grafted on GF677, planted in 2002 with a density of (3 x 5 = 667) trees/ha under Goblet training model with 4 starts. For the follow-up of the trial, the trees were selected randomly (DCA), after having excluded the trees from the borders and marked to facilitate their tracking. Measurements were made from January 30 to February 11, 2021, using a tape measure, and the number of structures as their distances and insertions were recorded. This measurement was done immediately after fruit pruning to maintain the trees' natural environment. Thinning was done, 46 days after full bloom. It should be noted that branch insertion angles were not taken into account because the weight of the fruit can cause some branches to bend towards the ground after fruit set, and these branches may not be able to regain an above-horizontal orientation after harvest [9].

These measurements were systematic to all tree structure and were made in the following order: first, the length of the trunk then the length at the base of the scaffold and so on until the last branch. Then, we move on to the second scaffold which is located at the left (clockwise rotation) and so on until all four scaffolds of the tree are completed.

All branches, including mixed branches (with leaf and flower bud) identified on the 10 trees, were tagged, and numbered by a black and resistant adhesive tape. In total, The study conducted on Nectarine variety of Spring Bright, by measuring 10 trunk, 40 frames, 157 1st underframe, 280 2nd underframe, 361 3rd underframe, 308 4th underframe, 134 5th underframe and 1250 of mixed branches on the 10 trees., The number of structures evaluated was higher than in both studies [3] and [10]. Statistical descriptive tables, graphical representations, and statistical parameters were used to characterize the data. Additionally, we used analysis of variance to compare the means, we applied the analysis of variance. The significance level retained was 5%. Statistical software SPSS version 26 was used.

Fig. 2. Measuring the length of a trunk and Mixt branch with measure tape

3. Results and Discussion

The preliminary analysis of the lengths concern focused on the evolution pattern and homogeneity of the data.

From the measurements, we were able to develop a database for each tree studied that could be used to diagram and draw all ofthe branches of the concerned tree. to understand the logical organization of this data, figure 3 shows in a simple way the hierarchical organization (in cm), of a part of a tree from its database,as well as the relative proportion, number, and ratio of different tree structures.

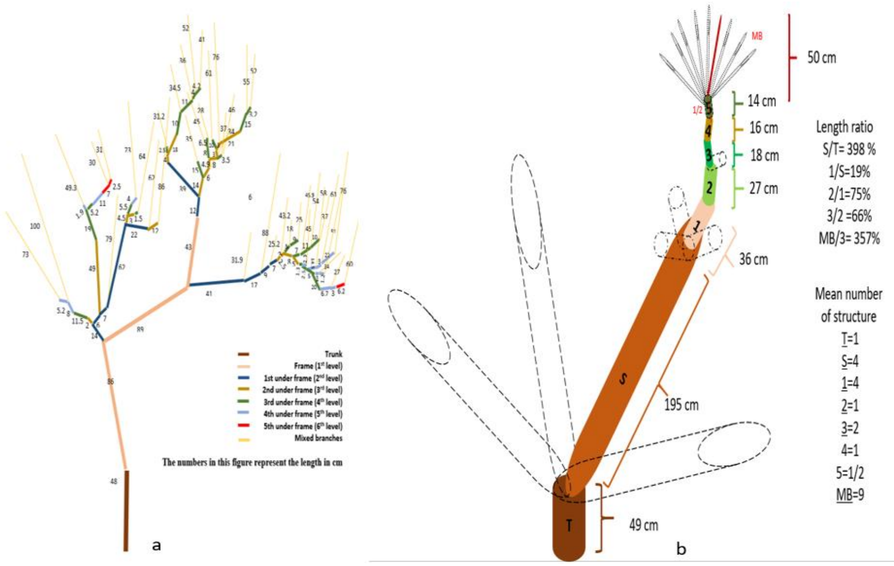

Figure 3: Illustration of length evolution (a) and a build model on reel proportion, number of structure and ratio (b) between different structures for the Nectarine Spring Bright variety (**S: scaffold;1: 1st level; 2: 2nd level; 3: 3rd level; 4: 4th level; 5: 5th level; MB: mixt branch**).

Assuming that the development of a tree is made up of architectural units (AU) that condition its shape and production potential. The AUs are grouped into categories with different specific morphological, anatomical and functional properties [11]. The stacking of AUs that is responsible for the architecture of a tree makes repetitive ramifications appear and will condition its production [11].

3.1. Trunk

The trunks length was homogeneous with only 5.01 standard deviations. The length was between 41 and 59 cm. This homogeneity due to the same training and fertilizing program.

3.2. Scaffold

The analysis shows structured heterogeneity (σ=35,5). For this reason, a grouping into relatively homogeneous classes was carried out. The analysis of the lengths of the organs of different levels shows a decrease of this parameter by going from the first level frames (the longest lengths) to the third level. This difference is significant ($p = 0.003$) and cannot be neglected to characterize the architecture of the trees and identify models for representing the tree structure, low lengths (below 160 cm), intermediate lengths (from 160 to 209 cm) and high lengths (above 209 cm) representing 20%, 40% and 35% respectively. The intra-class variation is relatively small and corresponds to σ= 9,86, 14,23 and 8,17 for the three classes respectively. The variability is more important for higher-level frames (Table 1). The shortest, less abundant (20% of the frames) have lengths of less than 160 cm while the longest ones exceed 209 cm with an intermediate slice, which are the most dominant with 40%, each (Table 1).

3.3. 1st level

Overall, the heterogeneity for the first frame are great (σ=32,54) and the most dominant are the shorter sub-frames, which measurements are between 10 and 85, subdivided into four categories, whose limits are 10, 25 and 85 cm. The longest represents only a small percentage of 14% and may exceed 150 cm (Table 1).

3.4. 2nd and 3rd level

The lengths of the seconds and thirds subframes have similar distributions, with significant differences (p=0.007) and are grouped into organs of low length not exceeding 25 cm and represent approximately 60% of the sub-frames of the same level. On the opposite, long underframes can have these measurements around 80cm. The intermediate class represents about 30% of the total (Table 1).

Table 1. different length measurement for all tree structure (cm)

LEVEL	TRUNKS				
CLASSES	Brute	-	-	-	-
MEANS	49,00	-	-	-	-
STANDARDD DEVIATION	5,10	-	-	-	-
LEVEL	SCAFFOLD				
CLASSES	Brute	C < 160	160 ≤ C ≤ 209	209 < C ≤ 250	-
MEANS	194,78	137,19	190,81	223,54	-
STANDARD DEVIATION	35,93	9,86	14,23	8,17	-
LEVEL	1sts UNDER FRAMES				
CLASSES	Brute	C < 10	10 ≤ C < 25	25 ≤ C < 80	80 ≤ C < 150
MEANS	36,23	6,23	16,10	49,37	104,35
STANDARD DEVIATION	32,54	2,32	4,38	15,77	16,99
LEVEL	2nds UNDER FRAMES				
CLASSES	Brute	C < 10	10 ≤ C < 25	25 ≤ C < 80	80 ≤ C < 150
MEANS	27,25	5,12	15,34	47,18	94,19
STANDARD DEVIATION	25,99	2,54	3,96	15,44	9,10
LEVEL	3rd UNDER FRAMES				
CLASSES	Brute	C < 10	10 ≤ C ≤ 25	25 < C < 50	50 ≤ C < 80
MEANS	17,87	5,06	16,61	34,64	61,45
STANDARD DEVIATION	17,52	2,77	4,17	6,67	7,82
LEVEL	4th UNDER FRAMES				
CLASSES	Brute	C < 10	10 ≤ C ≤20	20 < C≤ 30	30 < C
MEANS	15,72	1,73	6,59	14,81	32,87
STANDARD DEVIATION	13,28	0,69	2,22	3,03	10,42
LEVEL	5th UNDER FRAMES				
CLASSES	Brute	C ≤ 3	3 < C ≤ 10	10 < C ≤ 20	20 < C
MEANS	14,47	2,32	7,60	14,12	30,40

STANDARD DEVIATION	11,06	0,63	1,94	2,63	7,59

3.5. 4th level

The heterogeneity for the fourth level is great (σ=11,06 with a CV=76%) and the most dominant are the shorter sub-frames, which measurements are between 0,5 and 61, subdivided into four categories, whose limits are 10, 20 and 30 cm. The small (≤20 cm) represent 71% of all structure (supplementary data).

3.6. 5th level

The heterogeneity for the fourth level is great (σ=13,27 with a CV=84%) and the most dominant are the shorter sub-frames, which measurements are between 1 and 58. They are subdivided into four class, whose limits are 3, 10 ,20 and 30 cm. the number of structures in all class is somehow similar (C1:20; C2: 44; C3: 36; C4: 25) (supplementary data)

3.7. Mixt branch

Only mixt branches are longer than the structure below it with à ration of 357% just like the ration of scaffold and trunk. This result is logical because the mixt branch is the fruit-bearing organ so the producer maximises the length to maximise the number of flowers.
The decrease in length observed when going from a higher level (old or frame) to a level (young or under frame) is in agreement with the results obtained by [10]. They reported that, two phases of tree structure construction of apple tree remain valid for the length of the branches. [9] Marini have proven that short shoots less than 21 cm long have a high density of fruit buds, but produce small fruits. Shoots from 30 to 61 cm long are the most productive. The long and branched shoots produce fewer flower buds [9]. Thus, it would be desirable when pruning the orchard to favour, the shoots of the second category.

Agronomically, the sub-structures are always cut to short lengths in order to control the size of the trees and not gain unnecessary volume to the shape of the tree, which coincides with the results of [12]; [8]; [13] who have shown that tree yields increase potentially with their size, but not in a linear fashion because larger trees are less efficient. for this reason [9], in a concern for the sustainability of the production, recommends a pruning that would produce fruiting wood near the centre of the tree.

4. Conclusions

The current study of the different parts of the architecture of nectarine trees shows that the length can be grouped into classes with greater homogeneity. The pruning technique is supposed the main operation that produces such heterogeneity in all tree structures. However, the mixed branch and the scaffold have nearly the same ratio, because the former is the bearing-fruit structure and the latter is the support of the entire tree structure. In addition, the number of structures of each level combine with the number of flower or fruit can lead us to select the better level to construct a precise model for yield prediction. These findings suggest that branch length of nectarine trees is an important factor to consider in the management of these trees. A better understanding of the relationship between branch length and yield could lead to more effective management methods

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