Diameter characterization of the principal architectural structures for the Nectarine tree before flowering

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Abstract. This study aims to describe the variation of the diameter in architecture structure of Nectarine fruit trees located in Sefrou region. This characterization was realized before flowering by metric exhaustive and non-destructive measurements of all architectural organ to the supporting organs of fructification. The study conducted on Nectarine variety of Spring Bright, by measuring diameter of different tree structures: 10 trunk, 40 frames, 1234 underframes from level 1 to level 6 and 1250 of mixed branches for 10 trees that have been labelled and numbered. The characterization of the tree revealed the logic of the plant's construction, the diameters of the frames and their distribution were grouped in three to four homogeneous classes. The diameter was between 226,97 (trunk) and 7.31 (Mixt branch) mm with a standard deviation between 2.47 for mixt branch up to 23,29 for 1sts under frames .The diameter of the structure of a level is always lower than that of the superior level, but the comparison between the successive structure tree present a regressive diminution percentage in diameter. The diameter of different structures is homogeneous, with a low variability in all levels of the tree structures of Nectarine tree studied.

Keywords: Nectarine tree; Tree Architecture; Structure diameter.

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1. Introduction

The peach tree (*Prunus persica*) is one of the most cultivated fruit trees in the world. It extends on all continents, covering an area of approximately 1.5 million hectares, with a total production of approximately 16.5 million tons [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 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 diameter of the principal structures can lead to develop an accurate yield prediction model. Indeed, a higher trunk cross section area (TCSA) can lead to bigger fruit production with more weight [3, 4]. To do so, the diameter or trunk cross-sectional area (TCSA) and canopy is an essential key to predict the yield [5].

An accurate prediction model, would allow for early precise yield projection of Peaches and nectarine and subsequently, an early intervention to avoid problems in the chain. Indeed, the prediction of the harvest begins, first, with perfect knowledge of the diameter of different components of the architecture of this tree.

2. Material and Methods

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

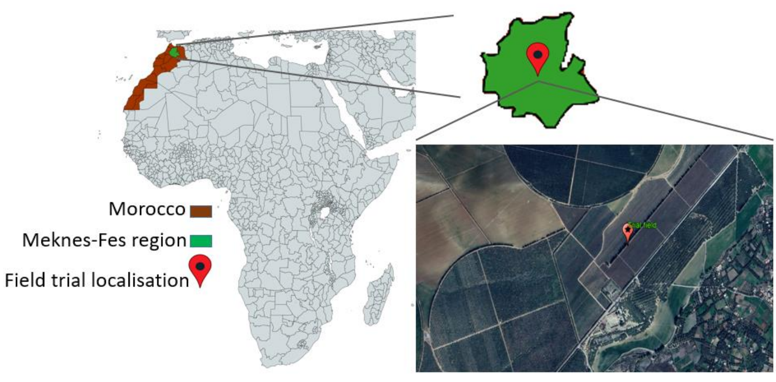

Fig. 1. field trial localization

The experiment was conducted on a homogeneous plot of Spring Bright grafted on GF677, planted in 2002 with a density of 667 trees/ha (3m *5 m) 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. The measurements were made from 30/01/2021 to 11/02/2021 (BBCH=0) with a tape measurement for trunks and first frame (figure 2 a) and with a digital calliper (the error of the equipment is 10-3 mm) for the rest level (figure 2 b). This measurement were realized just after fruit pruning in order to keep the trees in their natural environment. Thinning was done 46 days after full bloom. All the measurements were made at the same hour to prevent Trunk growth rate (TGR) and maximum daily trunk shrinkage (MDS) fluctuation especially for the calliper measurements [6].

Fig. 2. Measuring the diameter (a Calliper; b Tape measure)

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

All branches, including mixed branches identified for the 10 trees more than [7, 8]. The trees were tagged, and numbered by a black and resistant adhesive tape. In total, 10 trunks, 40 frames, 1234 sub-frames from level 1 to level 6 were observed while the number of mixt branches was 1250 for the 10 trees. The number of structures evaluated was superior to both studies Jiménez and Díaz [9] and Planchon [7]. Statistic descriptive tables, graphical representations and statistical parameters were used to characterize the data. In addition, for comparisons of means, the analysis of variance was applied. The significance level retained was 5%. SPSS version 26 software were used as a statistical software.

3. Results and Discussion

The preliminary analysis of the diameters concerns the evolution pattern and homogeneity of the data.

3.1. Trunks:

The trunks diameter was homogeneous with only 8,22 standard deviations. The diameter was between 208,5 and 240,4 cm. This homogeneity due to the same training and fertilizing program.

3.2. Scaffold:

The analysis shows structured heterogeneity (σ=10,53). For this reason, a grouping into relatively homogeneous classes was carried out.
As a result, we find three classes, C1: below 106 mm, C2: from 106 to 126 mm and C3: above 126 mm, representing 22.5%, 67.5% and 10% respectively. The intra-class variation is relatively small and corresponds to σ= 4,93, 5,26 and 2,76 for the 3 classes (table 1).

Table 1. different diameter measurement for all tree structure (mm)

LEVEL	**TRUNKS**				
CLASSES	Brute	-	-	-	-
MEANS	226,97	-	-	-	-
STANDARDD DEVIATION	8,22	-	-	-	-
LEVEL	**SCAFFOLD**				
CLASSES	Brute	C <106	$106 \leq C \leq 126$	C > 126	-
MEANS	113,23	97,92	115,89	129,74	-

STANDARD DEVIATION	10,53	4,93	5,26	2,76	-
LEVEL	**1sts UNDER FRAMES**				
CLASSES	Brute	C < 30	30≤ C ≤83	C > 83	-
MEANS	52,37	22,50	55,58	92,35	-
STANDARD DEVIATION	23,29	4,04	15,91	7,67	-
LEVEL	**2nds UNDER FRAMES**				
CLASSES	Brute	C< 19,9	19,9 < C < 40	40 ≤ C ≤60	C > 60
MEANS	32,44	14,23	28,36	49,18	68,85
STANDARD DEVIATION	18,06	3,81	5,02	5,75	6,55
LEVEL	**3rd UNDER FRAMES**				
CLASSES	Brute	C < 10	10 ≤ C < 30	30 ≤ C ≤50	C > 50
MEANS	23,73	8,62	18,20	38,11	53,36
STANDARD DEVIATION	12,43	1,00	5,16	6,00	3,34
LEVEL	**4th UNDER FRAMES**				
CLASSES	Brute	C < 10	10 ≤ C ≤20	20<C=<30	30 < C
MEANS	18,19	8,46	14,79	24,27	35,02
STANDARD DEVIATION	8,31	1,32	2,88	2,79	4,49
LEVEL	**5th UNDER FRAMES**				
CLASSES	Brute	C < 10	10 ≤ C ≤20	20 < C<22	22 ≤ C
MEANS	14,89	8,64	13,82	20,15	26,13
STANDARD DEVIATION	5,84	0,85	2,60	1,03	3,53

3.3. Under frames

For the 1st under frames, the diameters vary from 14.27 to 104.8 mm. However, this parameter is accompanied by a significant variability. Thus, the diameters of the first subgroups were grouped together in three classes, C1: lower than 30 mm, C2: from 30 to 83 mm and C3: higher than 83 mm which represent 21,01%, 68.79% and 10.19% respectively. The mean diameter of the first class is approximately 22.5± 4,04 mm, the second is 55.58 ±15,91 mm and the last one is 92.35± 7,67 mm (Table 1).
The diameters of the second subframe were grouped in classes with diameters below 19.9 mm (C1), between 19.9 and 40 mm (C2), between 40 and 60 mm (C3) and above 60 mm (C4), representing 31.29%; 37.5%, 21.94% and 9.71% respectively. The average diameter, of the under frames is around 14.23±3.81 mm, 28.36±5.02 mm, then 49.19±5.75 and 68.85±6.55 mm respectively for C1, C2, C3 and C4 (Table 1).
The most homogeneous class for the 3rd under frames was the large sub-structures with a diameter exceeding 50 mm with an average of 53.35±3.33 mm, which represents only 4.43% of the total. While the dominant class is that with diameters from 10 to 30 mm and an average of 18.19±5.15 mm. (Table 1).
The 4th under frames, regroup four classes with C1 inferior to 10 mm, C2: between 10 and 20 mm, C3: Between 20 and 30 mm and the last class superior to 30 mm (Table 1).

The 5th under frames has the same repartition as 4th under frames with the same classification (Table 1).

3.4. Relation between different structure diameters

The comparison between the diameter evolutions of different structure is logically diminutive. Indeed, like it shown in figure 3 the passage between trunk and scaffold is about 50 % and more the structure evolves more the structure is thin until 93% for the fifth frame (blue arrow) this corroborate the study of Barthélémy [10]. Although, the comparison between each tree structure and the successive one present less diminution (green arrow) a minimum between trunk and scaffold (50%) and a maximum (84%) between fourth and fifth under frames, perhaps because the fifth under frame are the mixt branch and they are the main fruit bearer structure so they have a higher diameter to support the fruits.

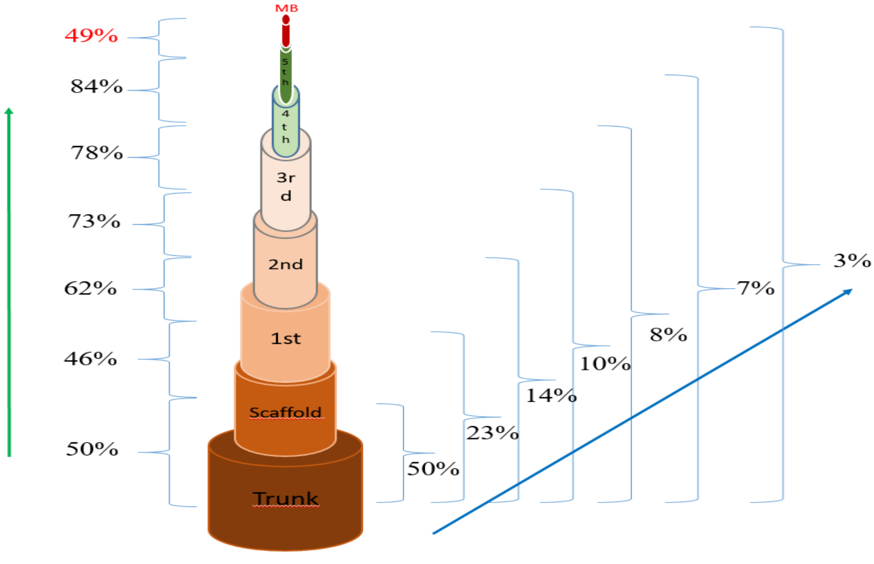

Fig. 3. Ratio between different tree structure and their level in percentage (MB: mixt branch)

Thus, the diameters of the frameworks of different levels are distributed in a gradual way from 106-126 mm to 19-40 mm through 30-83mm and 30-50mm. These results corroborate with the results reported by Robinson and Lakso [11].

4. Conclusions

The study of the different parts of the architecture of nectarine trees shows that the diameter parameter of Nectarine tree structures is more stable and homogeneous than that of lengths and could eventually be the basis for better prediction of fruit tree yields with metric measurements before flowering. It remains to link this homogeneity and stability of the readings with the production parameters, such as the number of fruits and their weight.

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