

Comparison of the technical management of avocado trees between Morocco and Spain

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Abstract:

The avocado tree is a tropical plant with economic, nutritional and health benefits, the development of this crop is necessary, a study has been conducted in this regard as part of technology transfer between Morocco and Spain. Based on the results of the surveys carried out, it was noted that there are common technical points and other differences in the technical conduct of the avocado tree between Morocco and Spain, from the point of view of varietal choice, choice of windbreak, semi-density, soil preparation, weed control, irrigation, fertilization, pruning formation, flowering, annular incisions, harvesting and packaging, and carrying technical routes that strongly influence the yield and preservation of the environment.

Key words: The avocado tree, technical management, irrigation, fertilization and environment.

I-Introduction:

The avocado is of Mexican and Guatemalan origin (Smith, 1969). During the 16th and 17th centuries and from these regions of origin, the Spanish spread the avocado tree. In Morocco, this tree has only been known since 1931 (Vogel, 1961), where avocado cultivation has increased in recent years from 2064 Ha in 2009/2010 to 3950 Ha in 2016/17, an average extension of around 270 Ha/year, while this extension has been 70 ha from 1995 to 2007. The region of Salé, Rabat, Kenitra covers most of this crop, about 76.02%, followed by the region of Tangier, Tetouan, al Hoceima, with about 17.85%, while the rest of Morocco represents about 6%) (M A P M , 2017). Although it accommodates a wide range of soils as long as they are well drained, the avocado tree prefers sandy or sandy-clay soils. It is sensitive to salinity. Concerning this parameter, the dominant soils in the crop areas in Spain are somewhat heavy while in Morocco the majority are light, which presents a constraint for the proper development of this crop. Environmental degradation, unequal distribution and excessive consumption of natural resources, climate change and the climate variability facing humanity today have negative effects on agriculture, agro-industry, supply chains and food security (Fischer et al, 2005). The avocado tree adapts perfectly to subtropical climates with mild winters. It can't stand the cold. Cultivation is more successful in humid climates with moderate and well distributed rainfall (1000 to 1600 mm). It should be noted that this parameter also does not appear in the areas where avocado is grown in both countries, thus presenting the second constraint of this crop. Under any climatic conditions, the technical management of the avocado tree plays an essential role in the survival and development of the plant, leading to a good yield with the preservation of the environment. The avocado tree's yields are highly variable depending on the varieties, cultivation techniques and soil and climate conditions. Agricultural practices guarantee consumers a healthy and high-quality product, and producers a very good yield, and therefore it is necessary to adjust production techniques such as good agricultural practices and the exchange of technology between farmers and even between neighbouring countries becomes necessary, to minimize to the maximum the effect of the constraints faced by the avocado tree in both countries, namely climate, soil and cultivation practices.

Material and methods.

1- Experimental protocol.

We developed a questionnaire in Morocco, which was based on several parameters concerning the various stages of the technical conduct of the avocado tree, also, surveys were carried out in Spain to highlight the different techniques of the conduct of the avocado tree, visits were organized in Spain with the director of the tropical

fruit laboratory in the orchard of the station to review the work in court, in other orchards monitored by the station, other visits were organized in Spain by technicians of the laboratory more precisely with Mr Emilio Eguardo and Josse Maria Hermosso to discuss irrigation by the use of tensiometers and probes, several meetings were held with a number of Spanish researchers, from Costa Rica and Japan in the presence of laboratory directors to review the best techniques for avocado tree management, visits were organized to the international nursery, such as Brokaw, to study the latest techniques at this level, visits were also organized to avocado marketing cooperatives such as Tropes.

For this study, in Morocco, thirteen orchards were selected in three geographical areas: the Gharb plain, the Bouknadal region and the Loukkos area. These three zones were selected because of the importance of their cultivated area in avocado 93.87% of the total area cultivated in Morocco (MAPM, 2017) and their climatic and edaphic conditions which are favorable to the cultivation of this plant. Indeed, because of their proximity to the sea, these three areas have a relatively high humidity and soils are sandy.

Precipitation and the nature of groundwater do not pose a problem for the development of this crop. Geographically, the thirteen orchards chosen are distributed as follows: two orchards in the Sale Bouknadl area, three near the town of Kenitra (Gharb area), one near the village of Moulay Bouslame (Gharb area), two near the town of Tazi (Gharb area), two near the village of Ouamra (Loukkos area), one near the town of Larache and one between the towns of Asila and Tangiers. In addition, all these orchards are distributed along the Atlantic coast over a 350 km stretch between Rabat and Tangier.

2- Parameters surveyed:

The parameters investigated are of two types: Those that are used before the creation of the orchard such as: The multiplication of the avocado tree, the design and creation of an orchard, the choice of windbreak, the choice of the variety and rootstock, choice of cropping system, soil preparation and proper planting.

The second group of questions concerns the management and maintenance of the orchard such as: Irrigation, fertilization of the avocado tree, tillage, weed control, pruning, annular incisions, brightening trees, over grafting, and Harvesting.

II-Results and discussions

1- Results.

Surveys show that there are techniques that are practiced in Morocco and are not found in Spain, techniques which are practiced in Spain and yet absent in Morocco, but there are still several common techniques used by the two neighboring countries, Table 1 shows the differences between these two countries in the technical conduct of avocado.

2- Choice of windbreak.

The wind causes branch breakage, falling flowers and fruits, burning of leaves and new shoots of the tree, in addition to dehydration, which prevents fertilization and fruit formation (Avilán and *al*, 1989, cited by Bernal, J. and *al*, 2014). The advantages of wind breakage in an avocado orchard, subjected to frequent and violent winds, is to allow better pollination and harvesting. Windbreaks reduce the drying of flowers and young fruits. They limit plant accidents and fruit loss. There is no difference between the two countries at this level. The choice of windbreak must take into account the competition with the avocado tree. In the Mediterranean area (Morocco, Spain), horizontal cypress (*Cupressus horizontalis*) and Arizona cypress (*Cupressus arizonica*) are the recommended species.

3- Preparation of the soil.

Land preparation depends on topography and existing vegetation. If the flat land is already cultivated, it does not require preparation. It is only necessary to trace lines and make holes 40 cm in diameter and 40 to 50 cm deep. If there are steep slopes or depressions, they are filled by leveling. The final plantation land, it must be subjected to a wet solarization treatment, for 45 to 60 days (Tamayo, PJ, 2007; ICA, 2012). Trenches should be constructed along contour lines for soil protection. We can also do the marking to sow contour to take advantage of the lines as constructions for the protection of the grounds. In Morocco, avocado growing areas are generally flat except for the north of the Lökkous region and do not require a lot of work, while in Spain there are different types of topography, hence more preparation work of soil.

4- Tillage and planting proper.

4-1- preparation of the ground

Tillage has a dual purpose: it reduces evaporation, eliminates weeds, and facilitates the burying of green manures. It is not necessary to work the soil which is close to the plant (the foliage), this technique is little practiced in Morocco and only for the young plantations. On the contrary, in Spain many farmers practice this technique even for the adult plantations.

4-2- Proper Plantation.

From a topographical survey, the parcels will be picketed, taking into account the access roads. According to the planned spacings, the location of each tree will be picketed. Then we go to the hole. There is no strict percentage rule for type A and type B varieties. For varieties with the same flowering time, these proportions can be 50 - 50, 25-75, 20-80. Hass pollinators (minimum 10%) well distributed in the plot should be sought, and pollinators should be located in the plantation in the part closest to the prevailing wind (Hernández and Hernández 2011). Regarding the planting period, usually there are two periods: Either in autumn for the avocado tree to settle in and benefit from the natural precipitation of the winter and make a good start in the spring. If there is low temperature to fear, it can be planted in early spring. In Morocco in the orchards surveyed, we encountered different densities, namely: 6x5, 7x5, 7x3.5, 6x6, 7x7, 8x4 and 8x8. Almost the same densities were found in Spain with dominance of the 7x4 density.

5- Fight against weeds

Weeds are undesirable plants in orchards of any fruit, since they are competent for nutrients, water, and sometimes for light. Weed control is a particularly important operation especially during the first years of cultivation. During the non-productive phase, an opaque plastic material may be used. However, weeds can be manually removed from the trunk by hand weeding.

During the productive phase, the need for weeding is decreasing especially with the elimination of the arrival of light to weeds by the foliage of the avocado plants. We must avoid the passage of tools near trees, so as not to cause small tears that can cause the entry of fungi such as Phytophthora.

In Morocco, weeding is done by plowing between the lines while it is done manually around the plant. In Spain it is done mechanically only between the lines. In addition, taster irrigation systems reduce weed growth.

6- Pruning and annular incisions.

Pruning is used to establish a balanced structure of shape and size, in cherry trees, early pruning has had a positive influence on the quality of the fruits of the following season (Measham and *al*, 2014), allowing them to take full advantage of their productive capacity. While ring incisions increase yield by blocking the passage of elaborated sap.

6-1 Training pruning

The main well-balanced structure of the plant must be formed, especially since avocado trees develop in an irregular manner and each variety contains its own particular characteristics. Formation pruning began in Spain around 1988 and is aimed at reducing the plant's growth in height, especially for vertically growing varieties. The basic assumption of central axis formation, similar to several popular apple and pear pruning shapes, protects the center of the plant from light and generally results in an increase in harvest. If you grow avocado for a while, you always have to deal with the problem of insufficient light, which reduces productivity. If the lateral shoots develop in excess, the tip of the central axis can be removed in an area where there are no lateral shoots. The lateral branches must be cut to balance the tree and control lateral growth. This delays the thinning of the tree, keeps it compact and improves light distribution. For the size of the training, there is not much difference between Morocco and Spain.

6-2 The maintenance pruning

This pruning consists in guiding the development of the plant, stimulating the growth of the wood while balancing the fruiting, facilitating certain cultural operations and limiting the height of the trees. Surveys show that this pruning is almost zero in Morocco whereas it exists in Spain.

6-3- The flowering pruning

Practised before flowering, it induces a flush development before the flower is induced, this growth will cover the fruit, protecting it from sunburn and frost (Vidiella, 2014). In addition, more recent studies have shown that this size has made it possible to reduce the phenomenon of alternation. This technique is no longer used in the orchards surveyed in Morocco, but ongoing supervised trials have begun to give extraordinary results, while in Spain it is well mastered by a number of technicians.

6- 4- Pruning of renovation.

To revitalize old trees, it is advisable to perform a severe pruning, leaving only a portion of the main branches. This technique is practiced in Morocco as well as in Spain to eliminate frost burnt framing.

6- 5- Annular incisions.

This operation can be done on the trunk of the tree, it consists in removing a part of the bark from 0.5 to 1 cm. In Palestine, the best time to use this technique is in October-November for the Fuerte variety.. Another narrow incision is made in April to increase the degree of growth of the fruit and improve its survival. Studies have also shown that the annular incision helps the grafting stock to release new buds with the presence of some growth regulators (Castro and *al*, 2005). Another study in Spain showed that the annular incision of adult trees is more effective in February than in October. (Martinez and *al*, 2003) this operation is moderately practiced in Spain, while in Morocco, there is a total absence of this technique for all the orchards surveyed.

7- Tree lightening and overgrafting.

7-1- Tree lightening

In order to obtain high yields from the first years of production, planting is carried out at a high density, but with the development of the trees, the opposite effects will be achieved. This must be done in a slow and gradual way so as not to affect performance in one fell swoop. In Morocco, the majority of orchards were planted at normal density, interspersed with other crops, during the first years of production. In Spain, some farmers have done this technique.

7-2- Grafting and its interest.

This is an operation performed when the arborist wants to change a variety, and this may be for a number of reasons. Therefore, it carries out grafting, which can be applied to trees of various ages as long as they are in good condition.

In Morocco, in the orchards surveyed, this operation is not carried out except for a few plants that have been burned by frost, for the same reason this technique is sometimes used in Spain or to change the variety.

8- Irrigation of avocado orchards

The demand for water and nutrients in the tree varies with the amount of vegetative and reproductive structures formed at each stage, which are considered critical components of total avocado production each year. (Andrea Torres, 2017). The success of irrigation depends on knowing the amount of water that requires a crop and the timing to apply it, (Dorado and *al*, 2017), and specifically for the case of avocado this mechanism of adjustment is very sensitive, and it occurs with a relatively low moisture deficit. There is an adequate relationship between supply and demand for water to meet the needs of the crop (Grajales, 2017). The root zone should be uniformly covered to maximize irrigation (Dorado and *al*, 2017).

8-1- Assessment of water requirements.

During the first year of the seedlings, the plantation must receive a sufficient quantity of water and especially during the dry periods and this to make a very good start of development, the distribution of precipitation is not uniform, which leads to a period of water deficit that coincides with the flowering and filling stage of the fruits (June-August), phenological stages of greater sensitivity to adverse environmental conditions such as water availability to meet the plant's water needs (Rebolledo and Romero, 2011). On the other hand, Silber and *al* (2012) report that adequate irrigation frequency is crucial for optimal fruit development. Sandy soils, which are a case of avocado cultivation areas in Morocco, have a very low water retention capacity of 4 to 6%, unlike clay soils, as is almost the case with Velez Malaga soils, which have a high retention capacity of 10 to 20%. In addition to this parameter, it is also necessary to take into account the evapotranspiration which increases with

the increase in temperature and with the presence of dry winds, which come from the East (chergui) and finally from the crop stage.

8-2 Quality of irrigation water.

The avocado breeds have different sensitivities to sodium and chlorine, it is generally appropriate to use irrigation water which does not exceed 3 to 4 meq / l of chlorine, and 3 meq / l of sodium. In Morocco, with the exception of a few orchards surveyed, the majority of farmers do not rely on the analysis technique. In Spain, on the other hand, the analysis of water is an essential step before the installation of the avocado orchard.

8-3- Irrigation techniques.

If the soil is sandy, it is necessary to increase the frequency of irrigation and decrease the quantity of water by irrigation, conversely for the clay soils, if one has an irrigation system which covers a small surface example the taste with taste, you must irrigate at the moment when the plant needs water. Well controlled irrigation can save 87% of the applied water volume and reduce total leached phosphorus by 74% compared to uncontrolled irrigation. (Kiggundu and *al*, 2012).

In Morocco, the majority of orchards are tasty and some orchards have the micro-jet while there is a single orchard among the surveyed orchards which has an archaic irrigation system (planetary irrigation), conversely in Spain the majority of orchards use drip although there is also a considerable area with micro-spraying.

9- Fertilization of the avocado tree.

9-1- Objective of fertilization.

The objective of fertilization is to allow a good nutrition of the plant, to improve or to maintain the natural richness of the soil so that the plant can express its genetic potentiality, but this operation must be economically profitable and without prejudices for the environment. The purpose of fertilization is to provide the plants with adequate quantities of essential elements, present in the soil but at deficit levels.

9-2 Determination of the needs of the plant.

The fertilization theme of the avocado tree is not clear enough, visual diagnosis is a means to assess the general situation of the plant. Soil and foliar analyses showed that the strongest demand phases were those of slow and linear growth in relation to nutrient extraction by the fruit (Ana María, 2013). Before establishing an orchard, a soil test must be carried out, which can be repeated if necessary, in addition to the foliar analysis that must be carried out each year for macronutrients and every other year for micro-nutrients for young trees, for sampling and for interpreting the results, it is advisable to consult a specialist.

Soil and leaf analyzes indicate whether nutrient levels are satisfactory. Fertilization is one of the most effective cultural practices to allow the plant to express its genetic potential and produce abundant fruits of good quality. We can also bring manure which has a dual role: fertilize and improve the texture of the soil, especially in the case of Morocco where the soil of the avocado growing areas is generally sandy. The way in which fertilizers are used affects yield, and can lead to inappropriate pH fluctuations (Serna and *al*, 2012). An experiment was conducted by Sobip in Mexico in 2006 showed the effect of foliar applications that facilitate uptake by the leaves, and thus increase production.

When nutrients are high in content, they can be a problem for the plant, either through a direct effect of the element on the plant, toxicity or antagonism with other elements (Castro and Gómez, 2008). In Morocco, almost all farmers use fertilizers based on other fruit trees or a random method, they do not rely on foliar analyses which are strongly recommended for this crop (Ben Taleb and *al*, 2016). On the other hand, in Spain, foliar analysis is strongly practiced in most yards.

10- Harvest and packaging.

In Morocco, the sector is not well organized and harvesting methods are archaic, leading to several cases of branch and fruit breakage. A ready-to-eat avocado must be flexible under the pressure of the fingers, the oil content in the fruit is the most commonly used harvesting criterion, it is accepted to collect early ripening varieties (Bacon, Zutano) with 19% dry matter, Fuerte with 20% and Hass with 21%. The fruit of the avocado tree for export is stored in air-conditioned stores (5 - 7°C). Rocha-Arroyo and *al* (2011), found for avocado Hass, in Michoacán State, Mexico, that complete fruit development took about 9 months.

In Morocco, it is noted that there is no good respect for the harvest period in such a way that we witness orchards that include late varieties and early varieties harvested at the same time for various reasons, knowing that the avocado that is not ripe has a bad taste, while in Spain we witness a good development in terms of harvesting, packaging and organization in the form of a cooperative.

Conclusion.

According to this comparative study of the technical conduct of the avocado tree between Morocco and Spain, it was noted that there are common and other technical points different from the technical conduct of the avocado tree, from the point of view of variety choice, semi-density, soil preparation, formation size and flowering size and carrying technical routes that strongly influence the yield and preservation of the environment. For irrigation and fertilization by comparing drip to micro-sprinkling: the wet surface increases, which increases a large volume of soil exploited by the tree, improves several parameters in the tree, namely good resistance to cold and heat, it also contributes to an increase in fruit load, a decrease in losses due to leaching, a saving of fertilizers and finally to the preservation of the environment.

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Table 1: Comparison of the technical management of the avocado trees between Morocco and Spain.

Surgery	Spain	Morocco
Windbreak choice	Cypress	Cypress, Eucalyptus
Soil preparation for cultivation:	More work	Less work
Ground work	Practiced even for adult planting	Little practiced and only for young plantations
Plantation proper	Practiced even for adult planting Various densities with dominance of 7 x 4	Various density
Weed control.	Mechanically	Manually
Pruning	Pruning of training, maintenance, renovation and flowering.	Absence of flowering size
Annular incisions.	Moderately practiced	Total absence
Thinning of the trees.	Moderately present	Totally absent
Overgrafting	Practiced in Spain.	Practiced in case of strong frost
Irrigation:	Drip + micro-spraying	Drip + micro-jet
Fertilization of avocado:	Based on foliar analyzes	Random.
Harvest and packaging	Presence of a good respect of the period of the harvest	Absence of a respect of the harvest period