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Challenges in orchard management for almond and pistachio

A. Lansari

Independant Fruit Tree Consultant,
AV des FAR, Residence Adnan, Appt 30, Meknès (Morocco)
e-mail: alilansari@ymail.com

Abstract. Almond and pistachio are the two main fruit nuts in the Mediterranean region and the USA. According to acreage importance and history in producing countries, USA is considered the latest country that introduced these two crops, starting by the beginning of the 20th century. Yet, the country has evolved tremendously in orchard management beside the other factors to assure high production to become the first almond and the second pistachio world producer. Mediterranean countries, where most of the acreage of these two species is located, developed good research and development in orchard management approaches and techniques and reached excellent production and fruit quality levels. However, their advances are uneven, slowed by the historical load of the crop and its management in their respective countries. At present, new issues have raised that will impact the future of orchard management. Per se, water resources shortage and fertilizers use in relation to climatic changes and soil contaminations, pesticides use in relation to environment pollution and health concerns, and the new developing trends such as bio, labeled and natural products. Thus the challenge in orchard management in pistachio and almond is greater since it should in the mean time aim to guarantee good and profitable economical yields and respect all the environmental and climatic changes concern.

Keywords. Orchard Management – Almond – Pistachio – Global Warming – Climatic Change – Greenhouse effect – Fertilizers – Irrigation – Pesticides.

Les défis dans la conduite technique des vergers d'amandier et de pistachier

Résumé. L'amandier et le pistachier sont les deux principales espèces de fruits secs dans le bassin méditerranéen et en Amérique du Nord. Les Etats Unis sont considérés le dernier pays à avoir introduits ces deux espèces au début du 20^{ème} siècle. Toutefois, le pays a réalisé une telle avancement en techniques de conduite en verger, associée à d'autres techniques de production, qu'il détient actuellement la première place mondiale en production de ces deux espèces. Les pays du bassin méditerranéen qui détiennent les plus grandes superficies de ces deux espèces ont réalisés de très bons niveaux de recherche et développement en techniques de production en verger. Toutefois, les résultats inégaux auxquels les différents pays méditerranéens sont arrivés sont reflétés par le poids de l'histoire de production de ces espèces dans leurs pays respectifs. Par ailleurs, de nouveaux thèmes agricoles sont d'actualité telle la réduction des ressources hydriques et l'utilisation des fertilisants minéraux en relation avec les changements climatiques et la contamination des sols, l'utilisation des pesticides en relation avec la pollution de l'environnement et la santé humaine et animale, les tendances vers les produits bio, labellés et naturels. Ainsi, le challenge en techniques de conduite des vergers d'amandier et de pistachier se reflète dans la garantie de la rentabilité économique des productions tout en s'alignant avec les chartes du changement climatique et du respect de l'environnement.

Mots-clés. Amandier – Pistachier – Techniques culturales – Changement Climatique – Effet serre – Irrigation – Fertilisants – Pesticides.

I – Introduction

Hunter-gathers would live off the land forging berry and edible plants, as well as hunting wild animals. These types of people lived in smaller groups because they had to be mobile to find more food. It was not until man began to plant and harvest crops that large permanent settlements could be established (Crisp, 1993). The crucial trap for the development of agriculture is the availability of wild edible plant species suitable for domestication. Farming arose early in the Fertile Crescent since the area had an abundance of wild wheat and pulse species that were nutritious and easy to domesticate (Diamond, 1997). Agriculture involving domestication of plants was developed around 11,500 years ago mostly in the Fertile Crescent (Hillman & al., 2001). Historically the fruit trees have evolved from simply as seasonal food gathered by the migratory nomadic, to a place of prominence in agricultural civilizations, often greatly sought after by those designing and developing cultivated gardens of the wealthy elite and emperors. Domestication of fruit trees seems to have started with olives 5 to 6000 years ago (Vossen, 2007). Domesticated almonds appear in the Early Bronze Age (3000-2000 BC) (Ladizinsky, 1999). The modern pistachio *P. vera* was first cultivated in Bronze Age Central Asia 2000 BC where the earliest example is from Djarkutan, modern Uzbekistan (Potts).

Agricultural techniques such as irrigation, crop rotation and the application of fertilizers were developed soon after the Neolithic Revolution 3000 BC, and farming changed very little until about 1700. In the 1700's, an agriculture revolution took place which led to a large increase in the production of crops, and in the 1850's, the industrial revolution spilled over to the farm with new mechanized methods which increased production rates (Grigg, 1974). Over the years man has invented new machines and techniques to increase the amount and variety of crop production and it appears that along the development of new varieties, production and management process seems to become difficult.

Advances in orchard management allowed fruit growers to produce larger crops of higher quality fruit year after year, generating surplus for wholesale in unprecedented volume. But with greater ease in production came chemical quality, food quality, and chemical residues concerns. As other fruit crops, orchard management on almonds and pistachios deals mostly with planting design and planting techniques, pruning, irrigation, fertilizers application, pest control, soil management and weed control, and harvest. The manner this package is adopted in the orchard management program will affect the final yield and the final quality of the nuts. In comparison to the Mediterranean almond and pistachio producing countries, high yields of US almonds and pistachio orchards are mainly explained by plantings on good soils and intensive use of water, fertilizers and pesticides. Almond and pistachio on most of the Mediterranean basin are of two types: 1) Scattered plantings of numerous local varieties or seedlings with low yielding potential, planted on marginal lands under rain fed conditions, characterized by low or no input. Most of these orchards generate low yields and poor fruit quality. This situation makes improvement through orchard management techniques difficult to reach; and 2) Modern farms with high yielding varieties, regular and intensive planting designs and adequate orchard management program. These orchards represent between 20 to 25% of the Mediterranean countries total acreage. In these countries, research and technology are gaining ground and higher yield and fruit quality are being obtained through improvement of orchard management.

As a conclusion, the difference in orchard management among almond and pistachio producing countries stands on variety performance, planting designs, level of mechanization, and use of water, fertilizers and pesticides.

In all the almond and pistachio producing countries, most of the improvement of yields and fruit quality is mainly bound to three orchard management techniques: water use, fertilizers and pesticides, beside soil fertility and planting design and spacing. The best example is the California almond history. The first almond orchards in California were primarily planted as done for centuries in Europe on hillsides without irrigation. As the industry grew in the first half of the 20th century, a revolution in California almond farming took place when growers discovered that planting orchards

in fertile, well-drained soils with irrigation and fertilization could double or triple yields (Sonk *et al.*, 2010). Rising global demand has spurred growers to plant almond and pistachio trees on the dry and salty soils of the west side of the San Joaquin valley, creating more water supply demand.

But as an Arabic proverb says: "overuse of resources will oppose expectations". As a matter of fact, California almond and pistachio industries are actually facing serious water shortage problems, just as the Mediterranean almond and pistachio culture have faced at all time. Within the Global Warming and climatic change debates, water resources shortage is a main issue. These facts lead to adoption of appropriate irrigation systems and accurate monitoring in orchard management.

On the other hand, pesticides have led to preservation of the trees, keep the soil weed free, guarantee superior yield and obtain high quality fruits. However, pest management became the epitome of intensive agriculture, observed in the chemical dependency of our management programs. The excessive and inappropriate use of pesticides conducted to the raise of resistant pathogen and insects strains, to insect unbalanced population dynamics, and to residues problems. Integrated pest management (IPM) should be the rule in any almond and pistachio orchard management program. Pesticide residues and health concerns opened the way to organic, labeled and natural almond and pistachio commodities. In developing countries, there is serious environment and health concern about pesticides banished elsewhere, misuse of pesticides and inappropriate handling of empty containers.

The third component in orchard management programs that should be watched closely is the use of fertilizers. Yet, fertilizers have surely played and still play an important role in improving almond and pistachio yields, but overuse of certain fertilizers such as nitrates led to serious soil and underground water contaminations and are finger pointed as a severe cause to the greenhouse effect. Nitrogen fertilizers applied to soils and soil management are estimated to be the major sources of N₂O production in agriculture. N₂O is 296 fold more harmful than CO₂.

II – Conclusions

Orchard management practices on almond and pistachios should be optimized to reach and maintain profitable economical yields with excellent commercial quality nuts. While some more advanced countries tripled yields and obtained excellent quality nuts at the expense of water resources, underground water and soils contaminations by excessive irrigation fertilizers and pesticides, other developing countries counter low yields and poor fruit quality due to lack in orchard management practices, either through low or no inputs at all or through absence of some orchard management practices. These orchards, usually under rain fed environment and on sloppy and/or poor quality soils, are at risk of being abandoned by farmers, thus contributing to rural exodus and climatic changes.

Orchard management is definitely highly needed to secure profits to almond and pistachio farmers. However, consequence of the actual management of these 2 crops in the different producing countries suggests a better implementation of the almond and pistachio management practices to reach and maintain profitable income returns in conjunction to Global Warming Solutions Acts and residues norms. Yet, USA is leading in finding solutions to water shortage and nitrate contaminations through actions such as the California almond sustainability program.

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