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Prospecting for Apple Tree Diseases in Tizi-Ouzou Region, Algeria

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Abstract
The apple tree *Malus domestica* is subject to a wide range of diseases, which can be fungal, bacterial or viral; these diseases can seriously impair its growth and production. By weekly monitoring, we identified four major diseases that have established themselves in apple orchards on four varieties: Anna, Golden delicious, Red delicious and Dorset golden, in Tizi-Ouzouarea. These diseases are fungal disease: scab, powdery mildew, and canker; and of the bacterial order: fire blight.

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INTRODUCTION

The apple tree *Malus domestica* is the most cultivated fruit species in the world in temperate zones for its edible fruit (Chouinard *et al*., 2000). The apple occupies an important part in the commercial exchanges with a world production of 80 million tons in 2014, ranked as the fourth most consumed fruit after citrus fruits, bananas and grapes (FAO, 2018). In Algeria, there are around 6,000 cultivated apple varieties, six of which constitute 90% of national production, occupying an area of 40,418 ha in 2014, with a production of 4,628,154 tones (MADR, 2018). This crop is the subject of much research to improve its production as well as its protection against its many pests and diseases.

In addition, in the Tizi-Ouzou region, cultivated apple tree areas increased from 596.5 ha in 2003 to 690 ha in 2016. This extension allowed an increase in local production from 32,091 to 113,990 Qx, for the same period (DSA, 2018).

The increase in production can also be attributed to several factors, mainly the improvement of applied apple growing techniques (production of young orchards, fertilization, soil maintenance, phytosanitary treatments, ordinary use of rootstocks and varieties, etc.). However, the apple tree, like all fruit trees, forms a favorable environment for the establishment of diseases (fungal; bacterial and viral) as well as animal pests including insects.

The objective of sustainable arboriculture is to produce quality fruit with minimal negative impacts on the environment and human health, caused by the misuse of pesticides against diseases and pests (Dubuis, 2010).

Therefore, it is necessary today to develop new methods of apple tree protection and to take into account their negative impacts, by implementing new agricultural practices that incorporate rational management of harmful organisms and respect the balance of the environment and human health. For this, it is essential to better understand the diseases that attack the apple tree.

The apple tree

Guiheneuf (1998) recalls the classification of apple tree as follows:

Branch	**Spermaphytes**
Under Branch	Angiosperms
Class	Dicotyledons
Under Class	Dialypetals
Order	Rosales
Family	Rosaceae
UnderFamily	Maloïdae
Genus	*Malus*
Specie	*M.domestica* (BORKH)

The genus Malus would number from 7 to 78 species, according to botanists (Janick *et al*., 1996; Juniper and Mabberley, 2006), but 25 species is often the number chosen (Phipps *et al*., 1990). It should be noted that classification to specific rank is difficult due to the great genetic diversity, potential hybridization as well as the presence of apomixes and polyploidy (Campbell *et al*., 1991).

Botanical characters of the apple tree

The domestic apple tree, *M. domestica*, is a fruit tree of the family Rosaceae, subfamily Maloideae, genus *Malus* (Figure 1).

Trees

Apple trees are hermaphrodite, they have twigs with brown bark, smooth, with many lenticels, becoming rough on old wood and bearing buds which may be vegetative or inflorescent **(**Delahaye and Vin, 1997). However, the volume of trees, as well as their longevity, depends on both the genotype of the scion and that of the rootstock (Pratt, 1990).

Roots

The apple tree has two types of roots, the main ones, thick and spreading, forming a horizontal layer less than 50 cm from the surface and the secondaries or verticals that descend to the impermeable layer or to the water table (Jackson, 2003). The activity of the roots depends on the humidity, temperature and ventilation of the soil. The temperature conditions, which can condition normal growth, are approaching +7°C, mineral absorption from +12°C and the optimal activity between 21 and 23°C (Guiheneuf, 1998).

Stem

The trunk of the tree is covered with a layer of hard, resistant and smooth bark, it can be detached by rectangular scales; apple tree bark color is gray-brown to dark brown in older plants (Bailey and Bailey, 1976; Webster, 2008; Cabi, 2012).

Leaves

The leaves of the apple tree are deciduous, alternate, simple, and entire and toothed at the edges; they have 2 leafy stipules at the base of the petiole (Pratt, 1990).

Flowers

The inflorescences of the apple tree forms a corymb with centrifugal flowering and are usually 6 in number. Great variability in the size, number and color of the petals (white to dark pink) was also observed (Morgan, 2002). The apple blossom is composed of 5 sepals, 5 petals, 20 stamens and a gynoecium with 5 styles united at their base (Pratt, 1990). The anthers have a longitudinal dehiscence that occurs a few hours after opening the flower. They release smooth pollen, unsuitable for transport by wind due to its weight. (Le Lezecand Thibault, 1986). The ovary consists of 5 fused inferior carpels each containing 2 ova, the ovary of the flower and the fused tissues surrounding it develop to form a fruit (Brown, 1975).

Fruit

The apple is a drupe with a fleshy mesocarp surrounding 5 cartilaginous cells, which contain the grains. This fruit is of variable color and taste depending on the variety, the final color of which is characterized by the final maturity of the fruit (Breteadeau and Faure, 1991).

Seed

The seeds are smooth, shiny; their brown tint characterizes the ripe fruit (Ziadi, 2001).In

each seed is an embryo with reserves that will be used for its germination (Delahaye and Vin, 1997).

Main apple diseases

A large number of diseases affect the apple tree (Table 1), parasitic fungi cause some, and viruses causing severe damage to the apple tree cause others (Bore and Fleckinger, 1997).

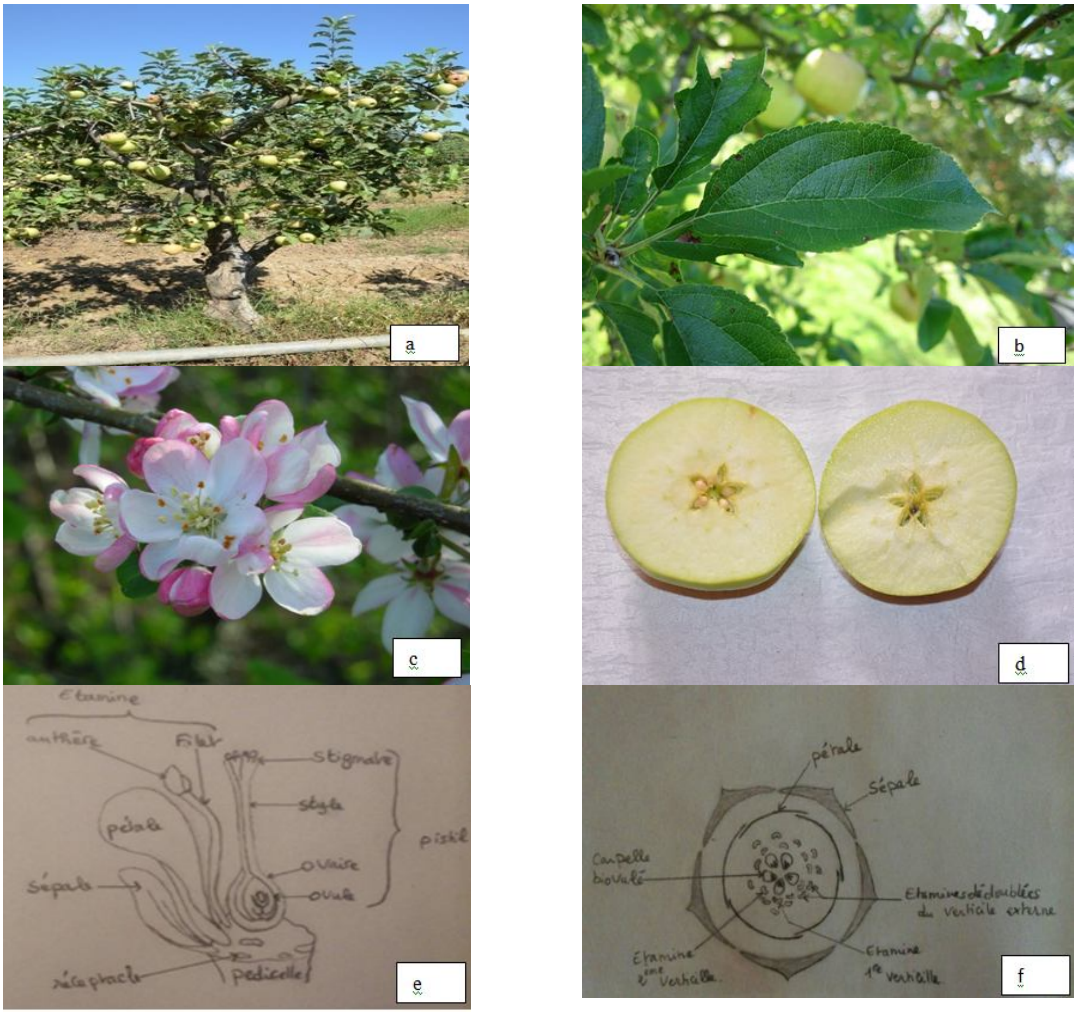

Figure 1: Morphological characteristics of the apple tree (Original, 2017)
a: fruiting apple tree.
b: apple leaves.
c: apple tree inflorescence.
d: Cross section of an apple showing the seeds.
e: Floral anatomy of an apple blossom (Trillot, 2002).
f: flower diagram of an apple blossom (Trillot, 2002).

Table 1: Main apple tree diseases (DSA, 2018)

Diseases	Vernacular name	Scientific name
cryptogamic	Apple scab Powdery mildew Crown canker Moniliosis Le chancre européen	*Venturia inaequalis* Cooke *Podosphaera leucotricha* Ell. &Ev. *Phytophtora cactorum* Lebert & Cohn *Monilia fructigena* Aderhold &Ruhl. *Nectria galligena* Bresad.
Bacteria	Fire blight Wilting floral bouquets	*Erwinia amylovora* Burrill *Pseudomonas syringae* Van Hall
Virus	The apple tree mosaic	*Ilarvirus* sp.

MATERIALS AND METHODS

The study was carried out on apple plots in the Tizi-Ouzou region (Figure 2) by direct observation of leaves and fruits of the apple tree on several varieties, namely: Anna, Golden delicious, Red delicious and Dorset golden, during the period from December 2013 to November 2015 covering the periods of vegetation, flowering and fruiting of the apple tree.

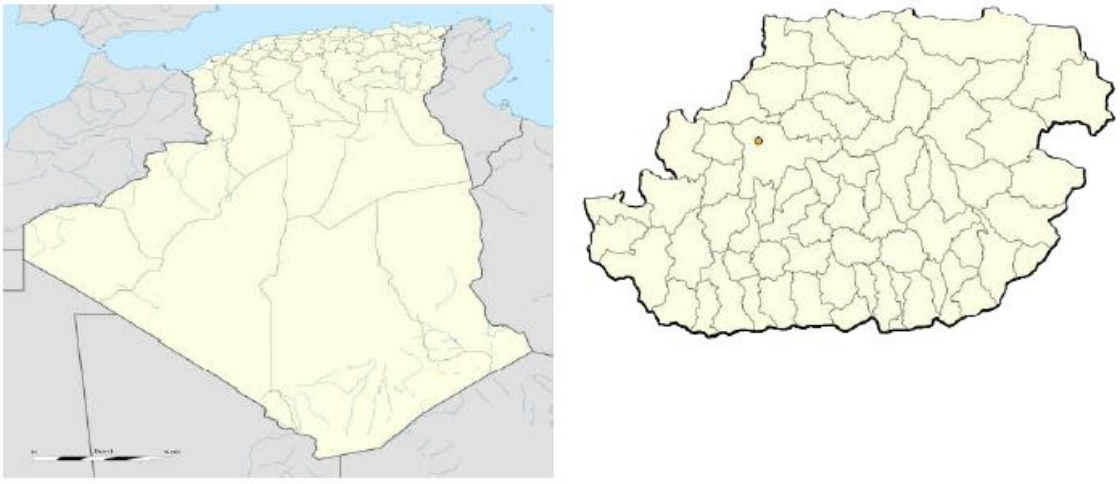

Figure 2: location of the study area in Kabylia

RESULTS AND DISCUSSION

During this study, we managed to identify 4 diseases that attack apple trees

Apple scab (*Venturia inaequalis*)
Scab is a fungal disease that attacks apple trees, it shows olive green spots on the leaves with a velvety appearance ; black spots on the fruit with cracking of the skin (figure 3).

The fungus is preserved in winter as perithecia in the leaves (dead on the floor). In spring, the perithecia are ripe and the ascospores are dispersed under the effect of the rains on the young organs of the tree: primary contaminations. The first spots appear about 20 days later constituting the first available outbreaks for new contaminations: secondary contaminations.

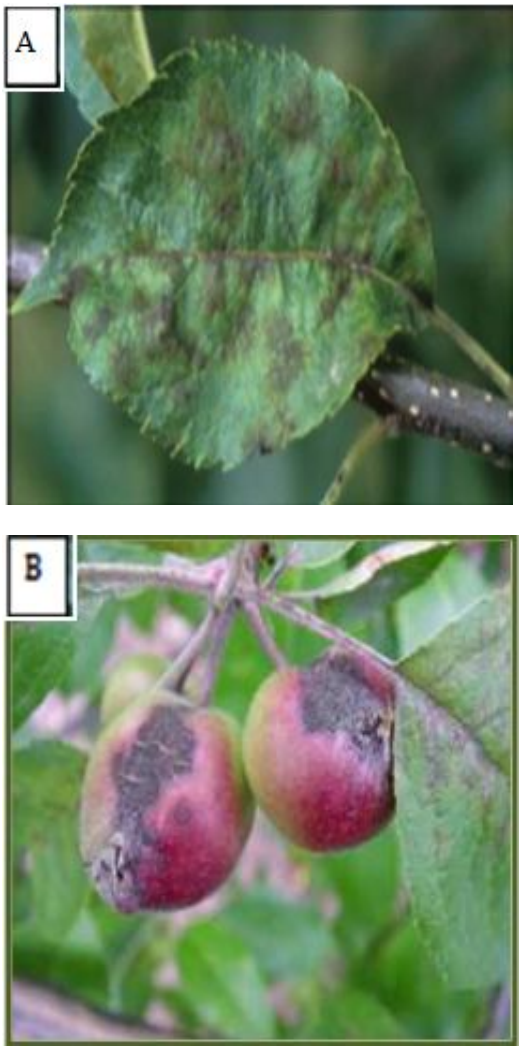

Figure 3: Apple tree infected with scab.

Primary attacks can cause severe yield losses and weaken trees. Late scab attacks compromise fruit storage and marketing.

Apple powdery mildew (*Podosphaera leucotricha*)
Powdery mildew is a fungal disease that attacks apple trees, It manifests itself in spring by a whitish down (formed by the mycelium of the fungus) which invades the affected leaves on both sides (figure 4). High humidity and high temperatures (greater than 10°C) favor it. This disease reduces the number of flowers and therefore the number of fruits.

Figure 4: Apple tree infected with powdery mildew.

Apple canker (*Nectria galligena*)
A canker on the main trunk can kill an apple tree if it spreads and ends up completely encircling the trunk. On a branch, the end of the branch beyond the canker will die or will become much less productive, without affecting the rest of the tree.

The attack of the twigs consists first of a small depressed spot on the shoots of the year or those that are one year old. Here the bark turns brown or takes on a bright reddish color. The attack very often takes place at the base of a bud or, if it is a sufficiently developed branch, at the base of a dart. Sometimes also, the penetration is carried out at the level of the lenticels.

Accidental wounds (waist wounds, graft cracks, various injuries) or even the attachment points of the picked fruit can serve as a gateway. The depressed area spreads into an elliptical chancre with concentric streaks around the point of infection. The destroyed bark leaves the bare wood in the center of the lesion. The canker thus formed gives the appearance of an "oyster shell" (figure 5). These successive cracks correspond to both the reaction of the parasite and that of the tree.

Figure 5 : Apple tree infected with canker.

Fire blight (*Erwinia amylovora*)
Fire blight is the most dangerous bacterial disease for apple fruit trees. On apple tree, because of infection, the flowers and leaves of floral clusters wilt and turn black. Under favorable conditions, entire branches can wilt and dry out within days. The still herbaceous tips of young infected twigs curl into a crook-like shape (figure 6). Unlike other diseases, infected and withered organs (flowers, leaves, fruits) remain attached to the tree.

Figure 6: Apple tree infected with fire blight.

Under conditions of sufficient humidity, droplets of exudate, rich in bacteria and polysaccharides, are produced on the surface of infected tissue. It is also a typical symptom of the disease.

CONCLUSION

Protecting apple trees against disease and conserving crops is undoubtedly the concern of any farmer. Thus, the study and prospecting undertaken allows us to learn about diseases present on apple trees in particular: apple scab, apple canker, apple powdery mildew and fire blight; in order to consider a rational control program more respectful of the environment.

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