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Interactions between date palm and Fusarium oxysporum f. sp. albedinis: A mini review

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Abstract – Fusarium oxysporum f.sp. albedinis is a fungal plant pathogen that causes a Bayoud disease of date palm, is the most serious disease of date palm in Morocco and in Algeria. This pathogen produces several toxins such us fusaric acid and its derivatives. Resistance of the date palm to Bayoud disease is linked to mechanical and chemical mechanisms. Several studies have shown that all North African quality cultivars are sensitive.

Keywords: Bayoud disease; date palm; Fusarium oxysporum f.sp. albedinis; toxins.

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1. Introduction

The date palm (*Phoenix dactylifera* L.) is one of the fruit species whose culture has existed since the earliest antiquity (Munier, 1973). "It is a stem of great interest not only for its high productivity and the quality of its fruit which are very looked for, but also due to its abilities to adapt the Saharan regions, where it allows to create a meso-climate inside the desert oasis that is favorable to the culture of several arboreal species, grain, forage and vegetable, which are associated with date palm whenever water is available" (Saaidi, 1990). However, this culture has continued to deteriorate in the Maghreb after being attacked by a lethal vascular wilt called "Bayoud disease" and caused by *Fusarium oxysporum* f. sp. *albedinis*. This vascular *Fusarium*, affects especially the best producing varieties of dates (Djerbi, 1982; Bounaga and Djerbi, 1990). To fight effectively of this phytopathogen requires a good understanding of the mechanism of pathogenicity of this fungus on the one hand and the means of resistance on the other hand. In this review, we will present and discuss the toxigenic potential of *Fusarium oxysporum* f. sp. *albedinis* (Foa) and the resistance mechanism used by date palm cultivars resistant.

2. Toxin production by Foa

Several studies have shown the mycotoxinogenic power of Foa. In this sense, it has been shown that the crude extract of the Foa filtrate contains about forty different products (Mokhliss, 1987) such as the fusaric acid derivatives. Similarly, the culture filtrate of the parasite allowed the distinction of three fractions F1, F2 and F3 with more than 50 mg / l for each (Sedra et *al*., 1993; El Fakhouri et *al*., 1996). These fractions are thermostable and their specificity has been evaluated (Sedra and Lazrek, 2011). The fraction F2 proved to be the most toxic on the palm tree (Sedra et al., 1993). According to Sedra (2013), the presence of these new toxins has never been reported in the filtrates of Foa cultures. Other toxic substances (subfractions H3, H4 and H5 in the F2 fraction) other than fusaric acid have been identified (Amraoui et *al*., 2005, Sedra et *al*., 2008, Sedra and Lazrek, 2011). This pathogen also produces several peptide phytotoxins in addition to fusaric acid and its derivatives (Sedra, 1995, El Fakhouri et *al*., 1996). In addition, there is a correlation between sporulation, fungus growth and quantitative toxin production. Chromatographic analysis shows that saprophytic strains of F. oxysporum do not produce these toxins produced by Foa (Sedra, 1997). These toxins can be used in In Vitro selection to distinguish resistant and Bayoud-sensitive material, using small seedlings from seeds, or tissue culture or fragments of young detached leaves (Sedra et *al*., 1993, 1998; El Fakhouri et *al*., 1996; Sedra and Lazrek, 2011).

3. Mechanisms of date palm resistance to bayoud disease

In their environment, plants are confronted with pathogenic micro-organisms such as viruses, bacteria, oomycetes and fungi. However, the plants effectively resist their aggressors and rarely develop severe symptoms of diseases. In addition to the constituent barriers, the plants have been able to put in place complex mechanisms involving the recognition and response to signals emitted following the invasion of pathogens. This recognition triggers defense mechanisms that generally converge toward the hypersensitive reaction (Mittler et *al*., 1996), cell wall enhancement (Shmele and Kauss, 1990), production of active oxygen forms (Doke et *al*., 1996) and the synthesis of phytoalexins and PR proteins (Durand Tardif and Pelletier, 2003). These responses are often associated with acquired systemic resistance or induced systemic resistance (Métraux et *al*., 2002). However, the induction of systemic resistance in most cases involves the diversion of the plant's metabolism towards the establishment of "very strong" and amplified defense responses to what is actually required in response to first contact with a pathogen. This developed defense arsenal, being too energy intensive, inevitably affects the growth and productivity of many plants (Heil, 2002; Walters and Heil 2007).

The mechanisms involved in defending the date palm against Foa are not well established despite the many efforts invested in this direction. This is partly due to the complexity of this pathosystem but also to the fact that most of the work has been done on plants from the seeds or "seedlings". These seedlings have a high heterogeneity in their behavior towards the pathogen, even if they originate from recognized susceptible or resistant mother plants (Dihazi, 2012).

Despite these difficulties, different study approaches have been adopted to understand the mechanisms of defense and resistance of the date palm against Foa:

- The comparison of infected date palms with healthy palms,
- Comparison of susceptible and resistant cultivars in the absence of any infection,
- The comparison of the defense responses of the two types of cultivars, susceptible and resistant, after their inoculation by the pathogen (Dihazi, 2012).

According to El Modafar (2010), resistance of the date palm to Bayoud disease is linked to multifactorial defense mechanisms, some of which are constitutive and others are de novo induced. Depending on their role in the defense strategy of the host plant, these mechanisms can be classified into two types:

- Mechanical mechanisms (reinforcement of cell walls by lignin and parietal phenols ...) which limit the action of the enzymes secreted by Foa and which intervene in the degradation of the cell wall in the date palm;

- Chemical mechanisms (defense proteins and phytoalexins, caffeoylshikimic acids, the accumulation of coumarin derivatives including propyl-7-aesculetin and 5-hydroxy-propyl-7-aesculetin ...) whose role is to inhibit the growth of Foa and to prevent the synthesis of its hydrolytic enzymes (pectinolytic, cellulolytic and proteolytic).

The resistance of the date palm to Bayoud disease also depends on Foa pathogenicity factors that can be distinguished as follows (El Modafar, 2010):

- Synthesis of enzymes degrading the cell wall and allowing penetration and colonization of Foa in host plant tissues;
- Secretion of suppressor protein that suppresses triggering of defense mechanisms in susceptible cultivars;
- Excretion of the toxins involved in the development of the symptoms of the disease.

4. Resistant cultivars

According to Fernandez et al., (1995), an inventory of the behavior of traditional varieties was conducted from field surveys or from naturally infested plots. It has been observed that a practically continuous variation of the Bayoud sensitivity from totally resistant to the most sensitive varieties such as Bou Feggous, practically disappeared from Morocco. However, a classification has been established that separates the varieties into three categories: resistant, tolerant and sensitive. Tolerant varieties are difficult to characterize. Some trees show symptoms of Bayoud but are able to survive for several years, unlike palms of susceptible varieties. Others appear healthy, but the parasite can be isolated from their roots, which is never the case in resistant plants.

Several studies have shown that all North African quality cultivars are sensitive (Deglet Nour, Ghars, etc.). Some cultivars have good resistance (Bou Sthammi black, Bou Sthammi white, Tadment, Iklane, Sair Laylet, Bou Feggous or Moussa in Morocco and Takerbucht in Algeria) but, among these cultivars, only Sair Laylet and Taqerbucht are of acceptable quality, when even lower than Deglet Nour or Mejhoul (Toutain and Louvet 1974; Saaidi, 1979).

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