Lentil rust in north-west of Algeria caused by *Uromyces viciae-fabae*

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Abstract

Lentil rust, caused by the fungal pathogen *Uromyces viciae-fabae* is a devastating disease and one of the major biotic constraints that can limit lentil production. Even though the northwest of Algeria is known for lentil production, there is no detailed information regarding the distribution, incidence and severity of lentil rust. The surveys were conducted during the 2018-2020 agricultural campaign in three regions of the Northwestern of Algeria (Mascara, Relizane and Tiaret). A total of 15 fields were surveyed. Rust incidence and severity were recorded from and plant samples were transferred to the laboratory for microscopic observation of the fungus. The result indicated that means rust incidence and severity value greater than 83.7% and 7.6, respectively were recorded in all filed surveyed and in the two agricultural years. Disease severity was classified as very high. Thevariety Syrie 229 was highly susceptible to rust disease. Two spore forms uredospores and teliospores of *U. viciae-fabae* were observed. Rust disease is mostly managed by chemical fungicides, but an integrated management approach that includes cultural measures, the use of resistant cultivars and biological control is recommended to control this disease.

Keywords: Algeria, *Lens culinaris*, Rust disease, Susceptible variety.

Introduction

Lentil (*Lens culinaris* Med.) is one of the major pulse crops in the world with high nutritional food and feed values. It constitutes a prominent source of proteins with an important amount of carbohydrates, dietary fibers, minerals, vitamins and antioxidant compounds (Joshi *et al.,* 2017). Lentil has been cultivated for its ability to fix nitrogen biologically where it is included in crop rotations with cereals for effective cultural control of weeds, diseases and pests by breaking up their life cycles (Kumar *et al.,* 2013). Lentil plants are generally grown as annual plants with hairy branches, the stems are narrow and light green in color (Gaad *et al.,* 2018).

Lentil is a potential adapted crop for dry areas in North Africa, South Asia, Sub-Saharan Africa, West Asia, and North Africa (Kumar *et al.,* 2013). In Algeria, it is one of the most consumed legumes after faba bean, chickpea and peas (Tabti *et al.,* 2018). However, its yield is still very low due to various biotic and abiotic constrains (Taylor *et al.,* 2007).

Lentil is affected by several diseases that can reduce plant growth and yield. Fungal pathogens are the most important one, which can decrease productivity by infection and damaging leaves, stems, roots and pods, as well as reducing marketability by discoloring seeds (Taylor *et al.,* 2007). Rust of lentils caused by *U. viciae-fabae* is a destructive disease that has a wide distribution and can impede lentil production (Negussie *et al.,* 2008). This disease can cause 100% losses in some countries where the development of the fungus is favored by moderate temperatures and humid conditions (Bejiga *et al.,* 2000). Rust disease affects all aerial parts of lentil plant; the earliest symptoms begin with aecial development on the leaflet during February. The aecia appear in a yellow single, round or elongated spots that gradually turns brown (Negussie, 2004). Brown uredinia are developed on both sides of the leaves, petiole, stems and pods and are formed in circular or oval shape (Khare, 1981). Telia are dark brown to black in colour, with a firm texture, and appear in the later stages of the plant, mostly on stems (Agrawal and Prasad, 1997). In severe infection, plants become stunted, dried showing burnt appearance and plants eventually die before seed formation (Chen *et al.,* 2009).

The present study aimed to survey and evaluate the lentil rust disease in the northwest of Algeria and to provide more information regarding the current state of lentil culture to rust disease attacks.

Materials and Methods

Surveys and disease assessment

Surveys were carried out in different lentil production regions, during the 2018-2020 agricultural campaign, data were collected from three regions (Mascara, Relizane and Tiaret) located in north-west of Algeria. The different symptoms are described.

The estimation of rust disease is carried by randomly selecting and diagonally 100 infected plants per parcel, the parameters determined during

these surveys are incidence and severity.

Disease incidence (DI) was calculated as the percentage of plants affected by rust per parcel, a plant with a leaf or stem showing symptoms is considered the "minimum threshold" for judging that a plant is infected with rust.

Disease severity (DS) was estimated as the percentage of infected tissue per plant which represents an estimate of the rate of symptom area developed on leaves and stems relative to the total plant area. Rust severities were scored on a 1–9 scale where 1 = no visible pustules and 9 = extensive pustules on leaves, petioles and stems, killing leaves and entire plant (Khare *et al*., 1993).

Sampling and examination of infected plants

Samples of plants infected with rust were collected at random from different farmers' fields for examination in the laboratory.

Results and Discussion

Lentil rust symptoms were found in all prospected sites during the period from 2018 to 2020. Rust disease is easily spotted in field; symptoms include dark-brown to black pustules on the leaves (Fig. 1A and B) and burnt stems (Fig. 2A and B). Typical lentil rust symptoms were observed as describes by Khare (1981), Negussie *et al.* (2004) and Chen *et al.* (2009, 2011). The percentage of infected plants varied from one plot to another, which is greater than 83.7% (Fig. 3), almost the same percentages were recorded in each crop year. The average disease assessment over the two agricultural years is presented in Figure 3.The highest disease incidence was recorded in Tiaret zone with 96.3%, followed by those evaluated at Relizane and Mascara zones (90.1% and 83.7%, respectively). The disease severity varies from 7.6 to 9 for all the sites prospected.

Uromyces viciae-faba is one of the yield limiting factors of lentil in Algeria, Morocco, Pakistan, Bangladesh, Ethiopia, India, Canada, Italy, Nepal, Syria, Turkey and South America (Bascur, 1993; Beniwal*et al*., 1993; Erskine *et al.,* 1994). This disease has the potential to cause yield losses of more than 60% and up to 100% reported in Ethiopia and India (Khare, 1981; Singh *et al.,* 1986).

The variety cultivated in all the plots surveyed is Syrie 229 (microsperma type), the recorded percentages of plants affected by the disease show that this Algerian variety is susceptible to rust. This variety is cultivated in the north-west Algerian fields for these agronomic characters (early, round seed (microsperma), green yellow color, high yield). It's moderately drought tolerant (Fatiha *et al*., 2019), and also cultivated especially for the high height of the lowest pods (14.9 cm) in comparison with other varieties cultivated on the Algerian fields (Gaad *et al.,* 2018). Height of the lowest pods above the soil is an important character for mechanization in lentil.

The presence of two forms of *Uromyces* spores (Uredospores and Teliospores) was observed microscopically on slides prepared from the infected samples; uredospores released from the pustules were unicellular, well grouped dikaryotic spores, light brown color, globular in shape, surrounded by a visible, pigmented and rough wall 20–30 × 18–26 µm (Fig. 4A). Urediospores are airborne and can induce new infections cycles during the season.

Teliospores produced from pustules were single-celled, subglobose, ovate or ellipsoidal, light brown with thick wall and papillate apex, 25–38 × 18–27 µm (Fig. 4B). Teliospores are the dormant stage of rust disease.

Rust pathogen *U. vicia-fabae* is a macrocyclic, autoecious fungus forming all spore forms (spermatia, aecidiospore, uredospore, teliospore and basidiospore) on a single crop with no alternative host (Cummins *et al.,* 1983).

During this study, we managed to observe two types of spores only (Uredospore and teliospores). In the epidemiology of lentil rust, teliospores play a critical role, they allow *U. viciae-fabae* to survive adverse conditions and produce basidia and basidiospores, which can infect lentil plants and initiate the infection cycle of rust disease.

Lentil rust disease can be managed through the application of fungicides as foliar sprays and seed-dressings; their efficacy is dependent on the time and number of treatments applied, as well as the stage of infection (Sugha *et al.,* 1994). Among the fungicides which are effective against lentil rust: Mancozeb, benomyl, thiram, zinc sulphate, carbendazim and triadimefon (Singh, 1985; Mohyud-Din *et al.,* 1999, Chen *et al.,* 2011; Emeran *et al.,* 2011).

The use of fungicides, on the other hand, is not fully efficient and may cause the selection of new resistant strains of pathogens, besides being costly and environmentally damaging. In many countries, the use of potentially harmful chemical sprays is regarded with dissatisfaction (Harman *et al.,* 2004). However, the most economically viable and environmentally sustainable method of control is the development of rust resistant varieties (Rubiales *et al.,* 2011). Lentil genotypes with some resistance to rust are now used in breeding programs where rust is a serious problem (Nleya *et al.,* 2016).

Several varieties resistant to lentil rust were reviewed by Chen *et al*. (2011) and Negussie *et al.* (2012) and which are available in Bangladesh, India, Ethiopia, Morocco, Ethiopia, Pakistan and Chile. The collection of Algerian accessions of lentil provided by Gaad *et al*. (2018) does not cite any of varieties resistant to lentil rust listed by Chen *et al.* (2011) and Negussie *et al.* (2012).

Several studies have been performed to explore the genetics of *U. viciae-fabae* resistance in lentil (Erskine *et al.,* 1994; Negussie *et al.,* 2005, 2012; Rubiales *et al.,* 2011, 2013), partial and hypersensitive resistance to rust in lentil have been

reported based on reducing and retarding epidemic built-up and resulting from prolonged latency period and reduced pustule density and size.

Pests and diseases including rust are affected by the different cultural measures such as soil preparation, planting date, plant density, fertilization, weeding, infected debris elimination etc, such practices can also influence plant health and thus the crop's growth and yield. For example, Mittal (1997) proved that delaying the sowing date significantly reduced the incidence rust disease, moreover, a maximum reduction in rust severity on lentil has been reported using a wider row spacing (15 cm) (Lal *et al.,* 2006).

Biological control is a promising alternative over chemical fungicide application. Among the antagonistic microorganisms, *Cryptococcus* and *Sporobolomyces* yeasts and *Trichoderma* spp. have been used for the biocontrol of *U. viciae-fabae* (Parker and Blakeman, 1984b). Isolates of *Trichoderma* displayed several mechanisms to suppress pathogenic activity of fungal parasites, including production of a wide range of broad-spectrum antifungal metabolites, mycoparasitism, and competition with pathogen of nutrients and space (Harman *et al*., 2004).

In conclusion, this study showed that the lentil variety cultivated in northwest of Algeria (Syria 229) is very susceptible to rust attacks. Further work is required on rust resistance in lentil through screening of local germplasm, including cultivated varieties, will provide important insights for disease management.

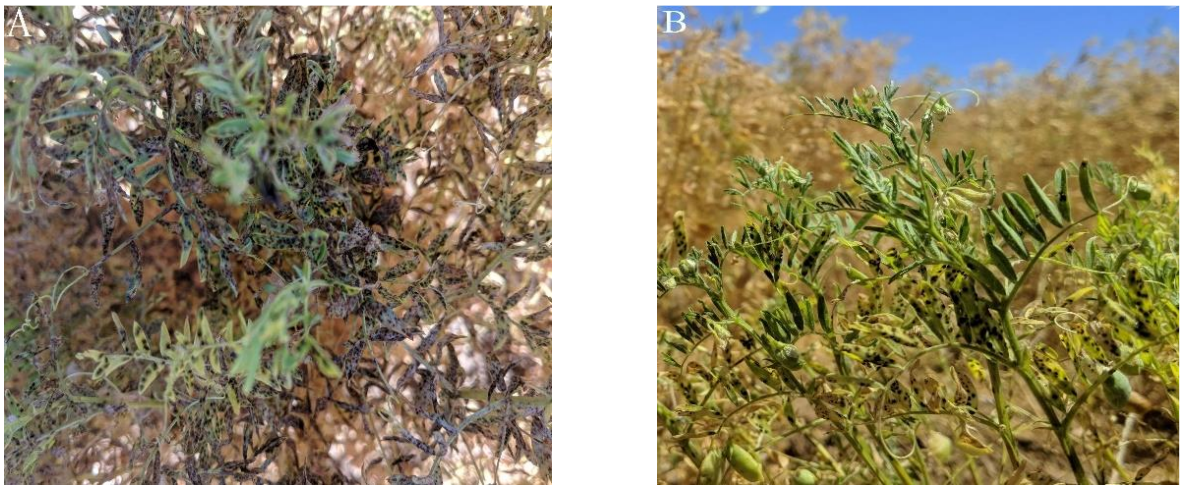

Fig. 1: Lentil plants infected with rust disease caused by *Uromyces viciae-fabae*. Leaves covered with black pustules.

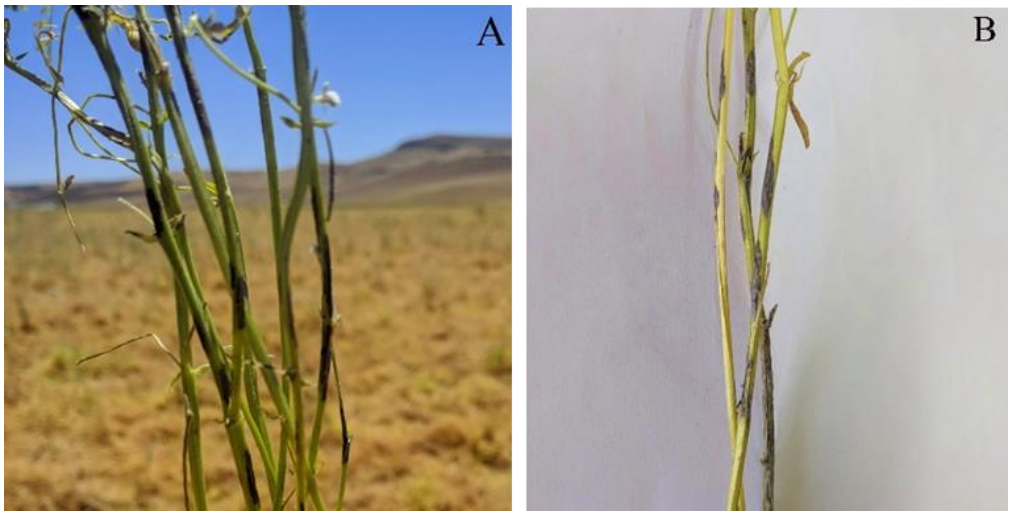

Fig. 2: Stem portions of lentil infected with rust.

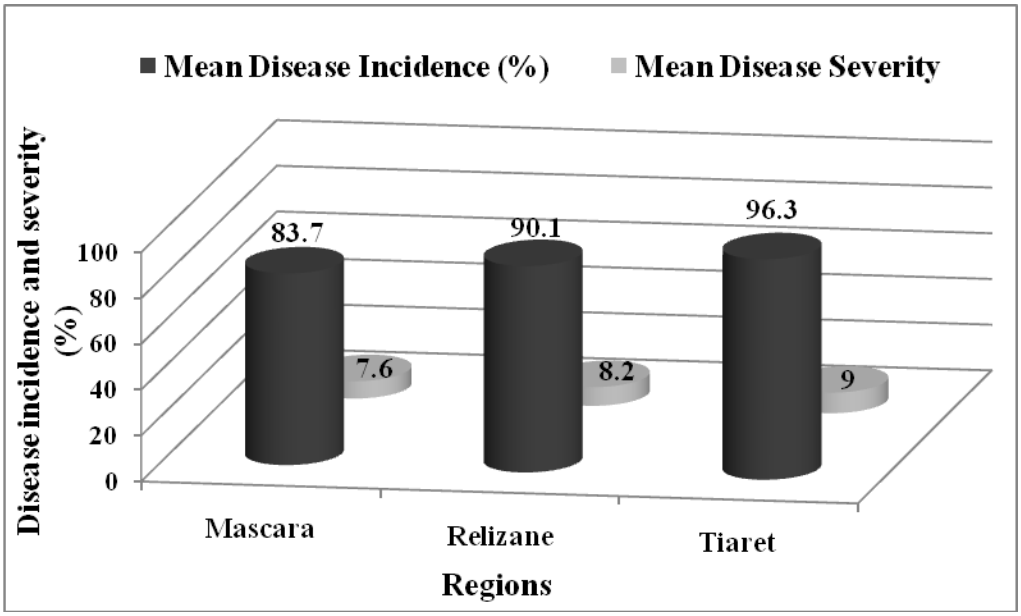

Fig. 3: The average incidence and severity of lentil rust recorded in different regions of northwest Algeria.

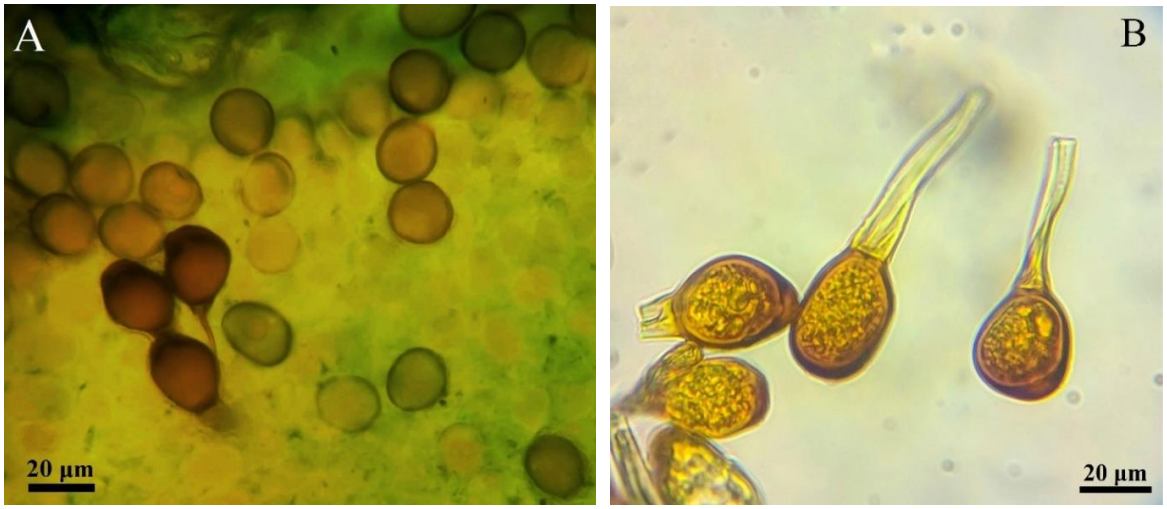

Fig. 4: Microscopic observation of uredospores (**A**) and teliospores (**B**) of lentil rust pathogen *Uromyces viciae-fabae*

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