

Occurrence of late blight in Algeria during 2009 and evaluation of potato cultivars for resistance to *Phytophthora infestans*

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SUMMARY

Prospections carried out in different production areas of potato in Algeria during spring 2009 showed severe epidemics of late blight in Western coastal (Mostaganem) and Central Western (Ain Defla and Mitidja) regions. In contrast, in Mascara location, the prospected fields revealed a low late blight frequency. Potato cultivars were tested for foliar resistance to late blight under controlled conditions and in a field trial. Our results showed a high susceptibility of most of the 13 tested cultivars and especially of cv. Spunta, dominant in Algeria, but an interesting resistance of cv. Sarpo Mira. Moreover, some cultivars exhibited variable level of resistance, according to the spore production of the two isolates used in the bio-assay.

KEYWORDS

Solanum tuberosum L., *Phytophthora infestans*, potato late blight, cultivar ranking, resistance components, *in vitro* evaluation, field trial.

INTRODUCTION

In the last decade, potato production areas in Algeria have known a large development. Late blight caused by *Phytophthora infestans* remains one of the most severe diseases of this crop. Since 2007, the disease caused drastic losses in the yields, particularly in regions where climatic conditions are highly favourable. In this situation, it was necessary to assess the frequency and intensity of this disease in various Algerian production areas. On the other hand, few informations are available about late blight resistance of potato cultivars grown under Algerian conditions. Two experiments were carried out in 2009 to evaluate foliar resistance level of several cultivars grown in Algeria : 1) an assay under controlled conditions, on detached leaflets with artificial inoculations and 2) a field trial under natural conditions of infection.

MATERIALS AND METHODS

Prospections for late blight occurrence

The prospections were carried out during April and May 2009 in two main regions : the central West (Mitidja and Ain Defla) and the West (Mostaganem and Mascara) of Algeria (Fig. 1). These locations have a high potential of potato crop, where they yield nearly 60% of the national production. In the prospected fields, seed tubers were planted during February until mid-March.

Disease occurrence was estimated by late blight frequency in each field (percent of diseased plants per field) and by disease severity (estimated on a scale from 1 to 9, where 9 value was completely necrosed plant).

Resistance test on detached leaflets

Nine potato cultivars were selected : Amorosa, Arinda, Armada, Arnova, Atlas, Liseta, Sarpo Mira, Spunta and Timate. Cultivar Bintje was used as reference because it is highly susceptible to late blight in European countries, but it is not grown in Algeria. The resistance test was carried out by artificial leaflet inoculations and incubation in humid chamber. Experiment was performed on four leaflets per cultivar and isolate. Each cultivar leaflet was separately inoculated with two A2 *P. infestans* isolates (Z1 and Z5), previously characterized by Beninal *et al.* (2009) and which are the two prevalent pathotypes in Algeria (Corbière *et al.*, 2010). Isolates Z1 and Z5 were respectively avirulent to *R9* and virulent to *R9*, and they overcome all the other 10 *R*-genes of Black's differentials. Leaflets were inoculated with a 20 µL drop of a suspension at 5×10^4 sporangia/mL. The necrose diameter and the sporulation intensity were respectively estimated after 4 and 6 days of incubation at 18°C. To quantify spore production, each leaflet was washed in 10 mL of water and sporangia production per lesion was determined with a haemocytometer, with three replicates per leaflet.

Field trial

Trial was performed in an experimental field in El Harrach (near Algiers). A total of 11 cultivars was evaluated: Amorosa, Arinda, Arnova, Atlas, Bintje, Désirée, Fabula, Kondor, Sarpo Mira, Spunta and Timate. Potato seeds were planted on 10th March according to a randomized complete block design with four replications. Trial was exposed to natural infections from local inoculum of *P. infestans*. Notations were weekly recorded from 25th April to 29th May, on 40 plants per cultivar. The number of diseased plants was evaluated in each micro field and late blight was scored on each plant, by a scale from 1 to 9 values, where 9 value was totally destroyed plant. An attack index (IAM) was calculated in order to evaluate the disease intensity on each cultivar, according to the formula :

$$IAM = \frac{\sum \text{Index of attack for each plant (1 to 9)}}{\text{Number of plants noted}}$$

RESULTS

Occurrence of late blight in Center and West of Algeria during 2009

A total of 40 fields were prospected during April and May 2009 (Fig. 1).



Figure 1. Main Algerian areas prospected for occurrence of late blight (in circles)

The mean late blight frequency and the mean disease severity per location, evaluated on May, is given in Table 1. The disease was the most important in the Central Algeria (Mitidja), with a frequency of 100% and an average severity of 7,5. In contrast, the weakest frequency was noticed in Mascara location where the disease severity did not exceed a level of 5 and with a weak frequency (not more than 10%). In the Western Algeria (Ain-Defla and Mostaganem), the mean late blight frequencies were respectively 50 and 66%, but it grew up to 100% in 6 fields of the 17 prospected ones. In Ain Defla region, late blight frequency fast increased from 2,5% to 50% in three weeks, from 13th April to 5th May.

Table 1. Frequency and severity of late blight in Central and Western Algeria on May 2009

Location	Mean area of fields (ha)	Prospected cultivars	Late blight frequency	Disease severity
Center : Mitidja - Blida	10 ha	Spunta, Fabula	100 %	7,5
West Center : Ain Defla	15 ha	Spunta	50 %	5,5
West : - Mostaganem,	1 ha	Spunta, Kondor, Désirée,	66 %	7
- Mascara	3 ha	Atlas	10 %	3

Assesment of potato cultivars for resistance on detached leaflets

Development of lesion diameters

After four incubation days, eight cultivars exhibited necrosis with the two isolates Z1 and Z5. Lesion diameter varied from 1 mm on cv. Armada with isolate Z1, to 27,5 mm on cv. Bintje with isolate Z5 (Fig. 2). In contrast, two cultivars, Arinda and Sarpo Mira, presented no symptom with one isolate. Cv. Arinda had no necrosis with Z5 and very small lesion with Z1, and cv. Sarpo Mira, no necrosis with Z1 and small lesion with Z5. Then, according to lesion diameter, seven cultivars were scored as susceptible, especially cvs Bintje and Spunta. Cultivar Armada was intermediate, because necrosis were observed with the two isolates, but these lesions were small. On the other hand, cvs Arinda and Sarpo Mira showed a high level of resistance to the two isolates. Moreover, these cultivars did not present any infection respectively with Z5 isolate (which overcome *R9* gene) and Z1 isolate (which did not overcome *R9*). Thus, these two cultivars expressed different and interesting resistance levels to *P.infestans*.

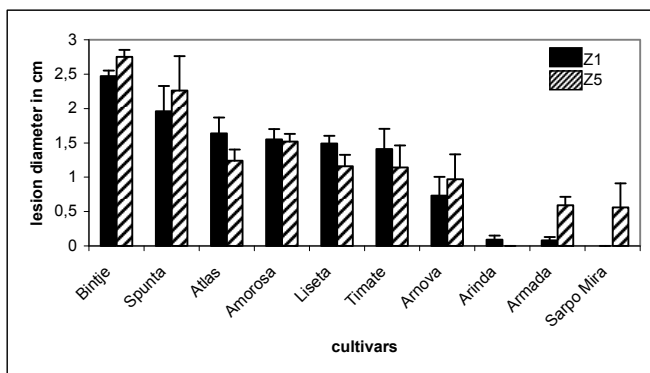


Figure 2. Lesions diameter of two different *P. infestans* isolates (Z1 and Z5) on ten potato cultivars and measured on detached leaflets, after 4 days of incubation.

The variance analysis of the values showed significant differences between the cultivars. The Newman and Keuls test (at 5% of significance) for lesion diameters, discriminated three rather homogeneous groups. The first one was composed of cvs Bintje and Spunta; the second one of cvs Amorosa, Atlas, Liseta and Timate, and the third one of cvs Arnova, Armada, Arinda and Sarpo Mira.

Sporulation intensity of the lesions

Sporulation, after six incubation days, was observed on all cultivars, with the two isolates, except on cvs Arinda and Sarpo Mira (Fig. 3). Spore production was variable according to the cultivar and to the isolate. The highest sporulation was noticed for cv. Bintje with isolate Z5 (2×10^5 sporangia/mL), while the weakest value was recorded for cv. Armada (10^4 sp/mL) with isolate Z1. Interestingly, no spore was produced on cv. Sarpo Mira with the two isolates, and on cv. Arinda, only few spores were produced with isolate Z5 and none with isolate Z1. On cvs Armada, Arnova and Atlas, sporulation was higher with isolate Z5 than with isolate Z1. Moreover, on cv. Atlas inoculated with Z1, sporulation was low, although lesion size was large.

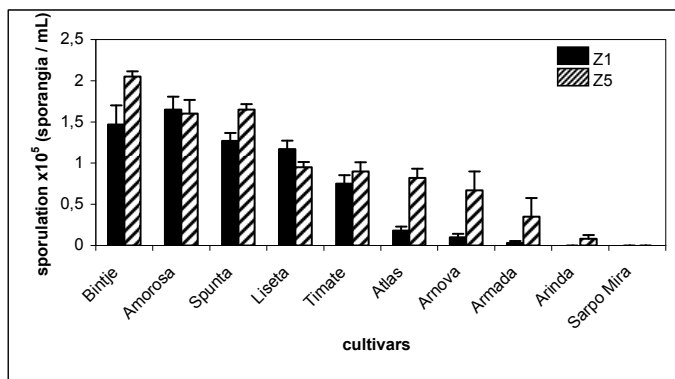


Figure 3. Sporangia production of two different *P. infestans* isolates (Z1 and Z5) on ten potato cultivars and measured on detached leaflets, after 6 days of incubation.

Variance analysis for sporulation data revealed significant differences ($P < 5\%$) between the cultivars, but rankings were different according to the isolates. With isolate Z1, three rather homogeneous

groups were discriminated; the first one was composed of cvs Bintje and Amorosa, the second one of cvs Spunta, Liseta and Timate and the third one of cvs Atlas, Arnova, Armada; Arinda and Sarpo Mira. With isolate Z5, cultivars were ranged into four rather homogeneous groups : the first one of cv. Bintje, the second one of cvs Spunta and Amorosa, the third one of cvs Liseta, Timate, Atlas; Arnova and Armada, and the fourth one of cvs Arinda and Sarpo Mira.

According to the two resistance components, cultivars could be classified into four groups :

- Sarpo Mira and Arinda were the most resistant ones.
- Armada, Arnova and Atlas moderately susceptible cvs.
- Amorosa, Liseta and Timate, susceptible cvs.
- Spunta and Bintje, the most susceptible cultivars.

Assessment of potato cultivars for foliage resistance, in a field trial

In the field trial, the average of attack index on the 11 cultivars ranged from 3 (resistant) to 7,5 (highly susceptible). Variance analysis of this attack index showed a highly significance between the cultivars and allowed to discriminate four homogeneous groups (Table 2). The most resistant cultivars were Sarpo Mira and Arinda, with the weakest attack index. Four cultivars, Atlas, Amorosa, Arnova and Kondor, had a relatively weak attack index and were moderately susceptible. Two others cultivars, Timate and Fabula, were susceptible. Finally, the most susceptible cultivars were Spunta, Bintje and Desiree with the highest attack index.

Table 2. *Attack index on 11 potato cultivars in a naturally infected field trial (late blight scored by a 1 to 9 scale values where 9 value = completely necrosed plant)*

Cultivars	Attack index
Sarpo Mira, Arinda	3
Atlas, Arnova, Amorosa, Kondor	5,3
Timate, Fabula	6,2
Spunta, Desiree, Bintje	7,5

DISCUSSION AND CONCLUSION

Our prospections showed that late blight epidemics were dramatic in all the prospected regions during spring 2009, except in Mascara. Disease was severe in Mitidga, Aïn Delfa locations and in the coastal Western part of Algeria (Mostaganem). In these regions, late blight epidemics were favoured by conducive weather conditions.

Most of the 13 cultivars tested for foliage late blight resistance were moderately susceptible to susceptible. The assay, carried out on detached leaflets with two isolates with different virulence patterns, confirmed the behavior of most of the cultivars assessed in the field trial, and especially the resistance of cv. Sarpo Mira. This cultivar, with pathotype-non specific resistance, seems to be promising, but it has been newly introduced in Algeria and is not frequently grown in this country. Our results are consistent with usually cultivar resistance ratings, *e.g.* for cvs Atlas and Arnova, moderately susceptible to late blight on foliage. Cultivar Spunta, dominant in Algeria, was highly susceptible to late blight and cv. Kondor, moderately susceptible, as it was also noticed with Moroccan *P. infestans* populations by Hammi (2003). However, these results need more investigations, *e.g.* resistance of cv. Arinda must to be confirmed. Indeed, in the European cultivated potato database, this cultivar has a low to medium resistance to late blight on foliage. Furthermore, according to Andrivon *et al.* (2007), Moroccan *P. infestans* isolates were locally adapted to cv. Désirée and were more aggressive on cv. Désirée than on cv. Bintje. In our field trial, we did not notice clear local

adaptation of Algerian isolates to cv. Désirée in comparison with cv. Bintje, and in the bio-assay, cv. Bintje was highly susceptible to the two Algerian *P. infestans* isolates.

Under controlled conditions, the cultivars, especially the most resistant ones, exhibited variable level of resistance, according to the spore production of the two different isolates. The expression of cultivar resistance and its spatial and temporal stability depend on environments, but also on characteristics of the local *P. infestans* isolates in each country. In Algeria, *P. infestans* isolates showed variability in their pathogenic traits (Corbière *et al.*, 2010). The accurate host resistance and knowledge of cultivar responses to disease has then to be assessed with current and diverse Algerian *P. infestans* isolates. Therefore, further work needs to be performed to evaluate cultivars for durable resistance in Algeria, under various environmental conditions, and also to explore diversity and pathogenic traits of Algerian *P. infestans* populations. However, this study provides informations on potato cultivar resistance usefull to develop effective, integrated disease management programmes in Algeria.

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