Identification of pea accessions with combined resistance to Fusarium wilt and drought

Nicolas Rispail[1], Mustafa Bani[1,2], Diego Rubiales[1]

[1]Institute for Sustainable Agriculture – CSIC, Alameda del Obispo, Avda. Menendez Pidal s/n, 14080 Cordoba, Spain.
[2] Ecole Nationale Supérieure de Biotechnologie, ville universitaire Ali Mendjeli, 25100 Constantine, Algérie.

Introduction

Pea, *Pisum sativum* L. is one of the major legume crops worldwide. However, its yield remains relatively low mainly due to its high susceptibility to stresses (1). Pea is particularly susceptible to drought and to fusarium wilt caused by the soilborne fungal pathogen *Fusarium oxysporum*, whose damage is favored by warm temperatures and dry weather (1). Loses caused by this pathogens are thus expected to be more severe and widespread in future due to climate change that also predicted an increase of drought prone areas. The use of resistant cultivars is currently the most efficient control approach (2). However, the existing resistance level introduced in legume cultivars is still insufficient. It is thus crucial to identify and exploit new sources of resistance to *F. oxysporum* and drought. This requires to establish rapid and efficient screening techniques. …

Objectives

(1) Establish the optimum method to screen for fusarium wilt resistance

(2) Identify pea accessions resistant to *F. oxysporum*

(3) Identify pea accessions combining *F. oxysporum* resistance with drought tolerance

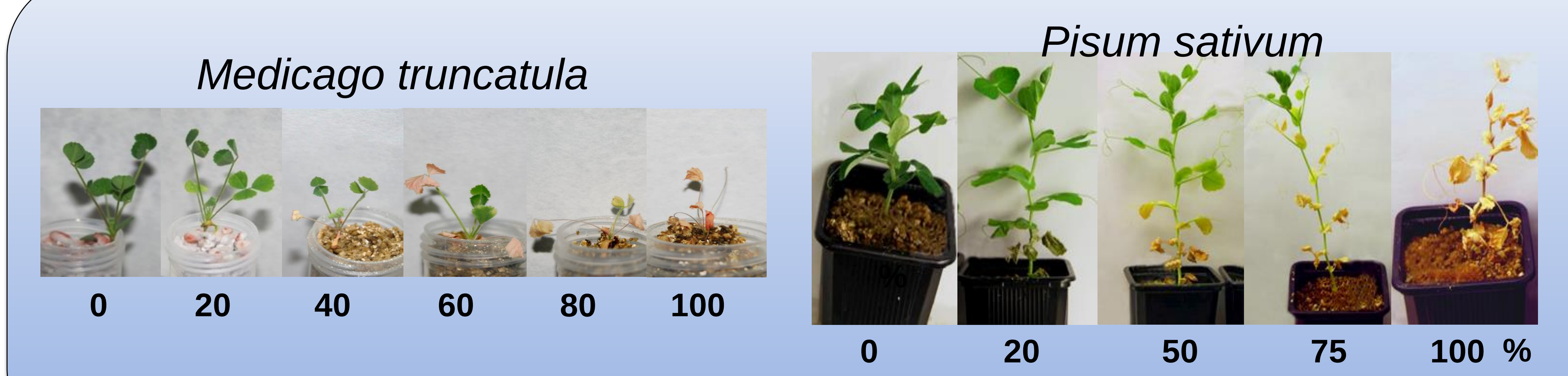
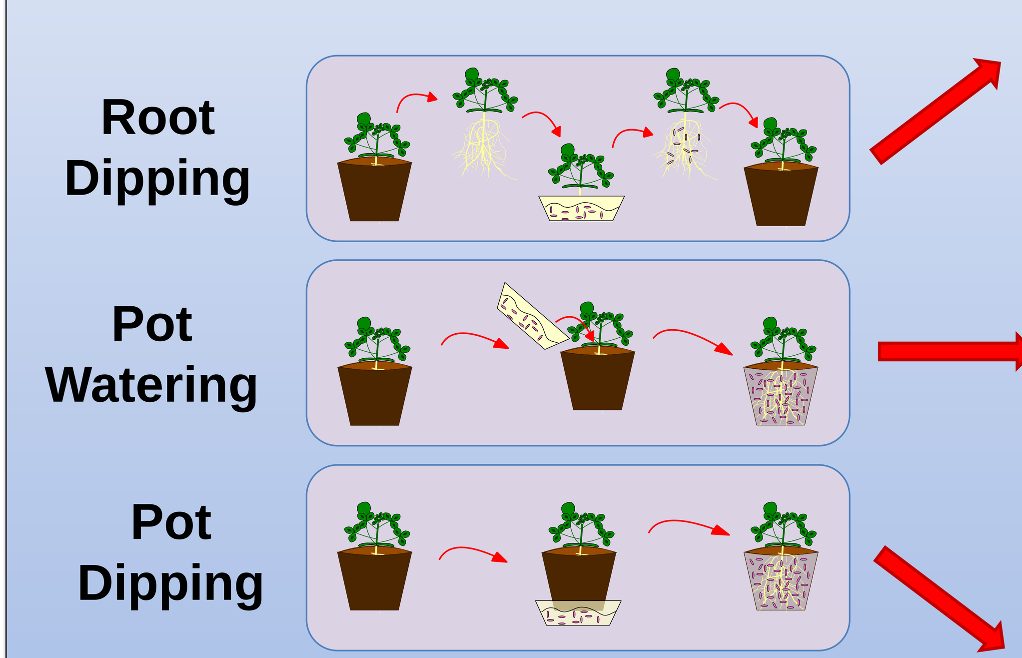


Figure 2. Visual scales used to evaluate fusarium wilt symptoms in *M. truncatula* and pea.

A. Establishment of optimal screening method

Many factors influence fusarium wilt severity in controlled conditions (3). Among them, the inoculation method was recently shown as one of the main determinant of fusarium wilt development (4). Thus, we tested the efficiency of three different inoculation methods to conduce fusarium wilt (Figure 1) on two *Medicago truncatula* accessions with differential response to *F. oxysporum*. In all cases inoculation was performed on 15-day-old plants with *F. oxysoprum* f. sp. *medicaginis* strain 605 and plant symptoms was followed from 7 to 30 days post-inoculation (dpi) by estimating the percentage of leaves with symptoms (Figure 2).

The inoculation method largely impacted disease severity. The root dipping method was the most efficient inducing wilt symptoms as early as 7 dpi and leading to complete plant death of the susceptible accession by 15 dpi (Figure 1). Root dipping was also the best to discriminate between control/Inoculated plants and between genotypes. Pot watering was also discriminating but wilt symptoms were slightly delayed and milder (Figure 1). By contrast, the pot dipping method only induced mild and largely delayed fusarium wilt symptoms in the susceptible accession PI 577607 while the partially resistant A17 accession remained symptomless (Figure 1).



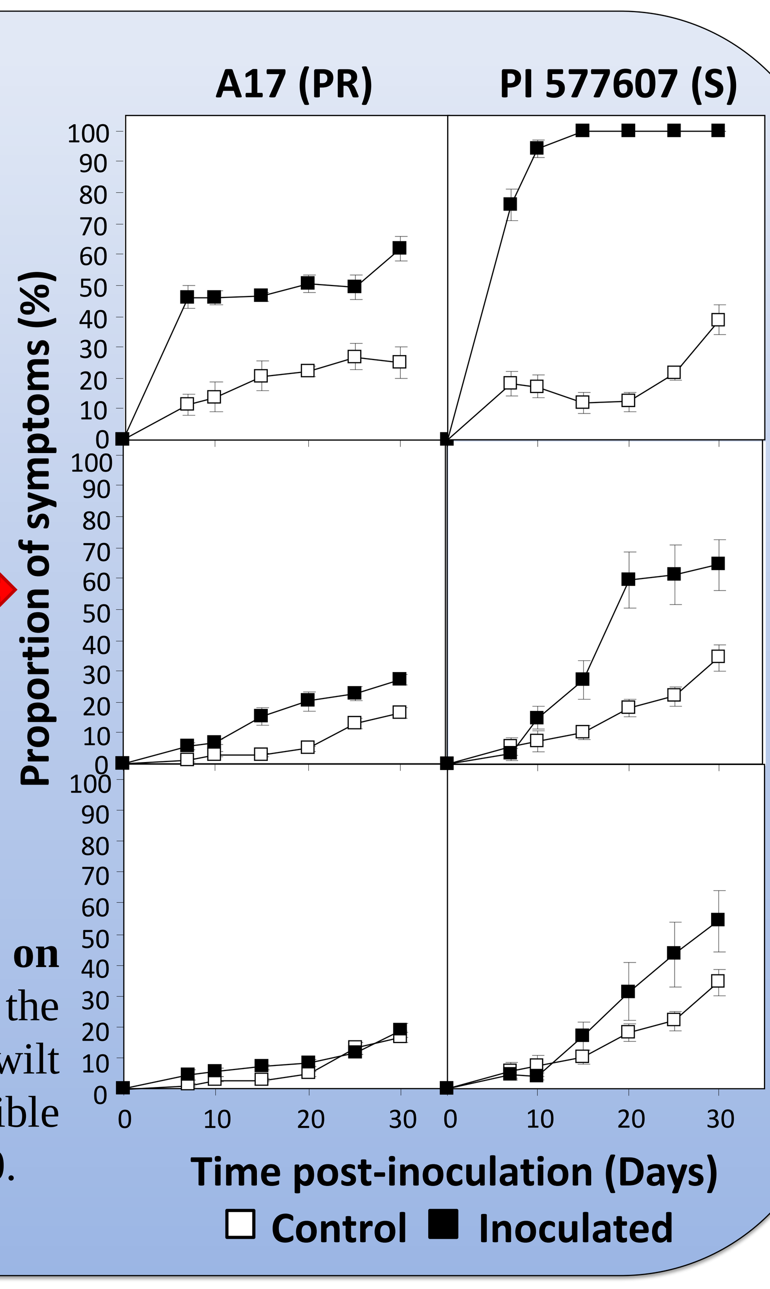


Figure 1. Impact of the inoculation method on fusarium wilt severity. Left Panel, Diagrams of the inoculated method tested. Right panel, evolution of wilt symptoms on the partially resistant A17 and susceptible PI 577607. Horizontal bars are standard error for n=10.

Concluding Remarks

- ❖ **The root dipping method is the most efficient method to screen pea and *M. truncatula* for fusarium wilt resistance**
- ❖ **9 pea accessions resistant to race 1 and 2 of *F. oxysporum* f. sp. *pisi***
- ❖ **Drought tolerant pea accessions were identified associated or not with *Fop* resistance**

B. Screening pea germplasm to *F. oxysporum*

The optimized method was used to screen a collection of 80 accessions of *Pisum* spp. of worldwide origin against *F. oxysporum* f. sp.*pisi* (*Fop*) race 2. 24 of them were also tested against *Fop* race 1. Seven-day-old *Pisum* spp. seedlings (2–3 node stage) were inoculated with the dip root technique. Disease symptoms were assessed from 7 to 30 dpi by estimating the percentage of leaves with symptoms (Figure 2) to calculate the area under the disease progression curve (AUDPC).

Large variation in the disease response of the *Pisum* spp. accessions to race 2 was observed confirming the quantitative nature of resistance to this race (Figure 3)(2). In addition, we identified 14 and 18 accessions with complete resistance to race 1 and 2 respectively while 9 accessions were highly resistant to both races (Table 1).

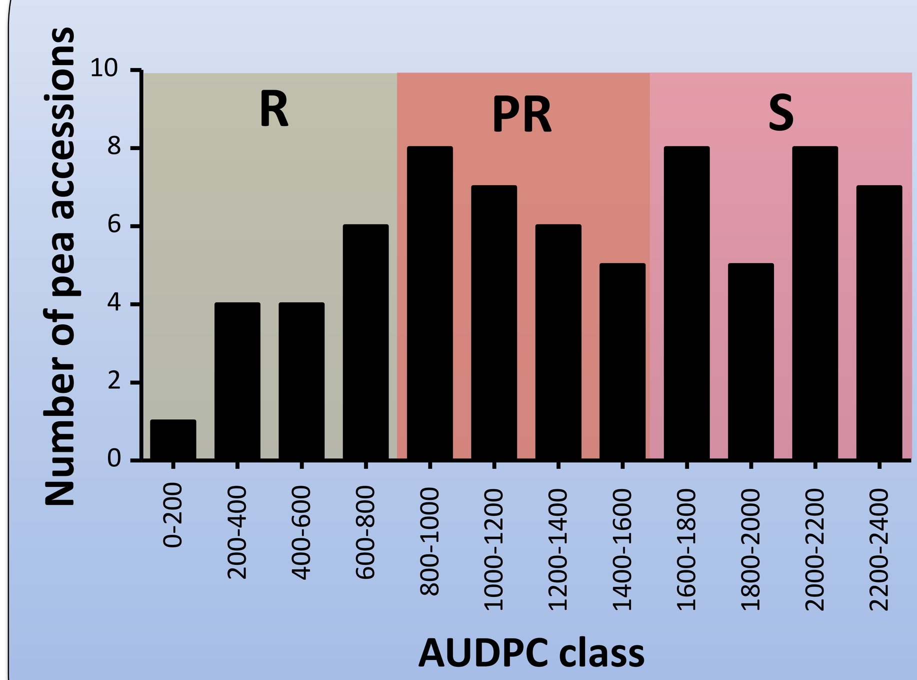


Figure 3. Distribution of the pea accessions upon inoculation with *Fop* race 2

Table 1. Disease response of *Pisum* accessions to *Fop* races 1 and 2

Accessions	Race 1	Race 2
JI1760	R	R
JI1412	R	R
P42	R	R
P639	R	R
P615	R	R
P632	R	R
P627	R	R
PF669	R	R
P638	R	R
P316	R	PR
MES	R	PR
DSP	R	S
P629	R	S
JI210	R	S
P633	S	R
P23	S	R
P614	S	R
P656	S	R
MINI	S	R
JI1559	S	R
P18	S	PR
P650	S	S
P662	S	S
LM	S	S

C. Screening for drought tolerance and *Fop* resistance

Climate change is expected to increase drought-prone areas and fusarium wilt incidence in these areas. Identification of pea accessions combining drought tolerance with *Fop* resistance is thus key for future pea breeding. For this reason, we evaluated the response of a set of pea accessions to (terminal) drought, to *Fop* infection and both stresses combined.

The results obtained revealed that *Fop* resistance and drought tolerance are not genetically linked (Figure 4). Although most accessions susceptible to *Fop*, such as Kebby, were also susceptible to drought, a few of them, including P650 were tolerant to drought (Figures 4 and 5). Conversely, most accessions resistant to *Fop* including New Season were susceptible to drought. Interestingly we identified one accession, JI 1412 that combined *Fop* resistance and drought tolerance. Combining these different resistance/tolerance sources would be very valuable to breed pea for the future

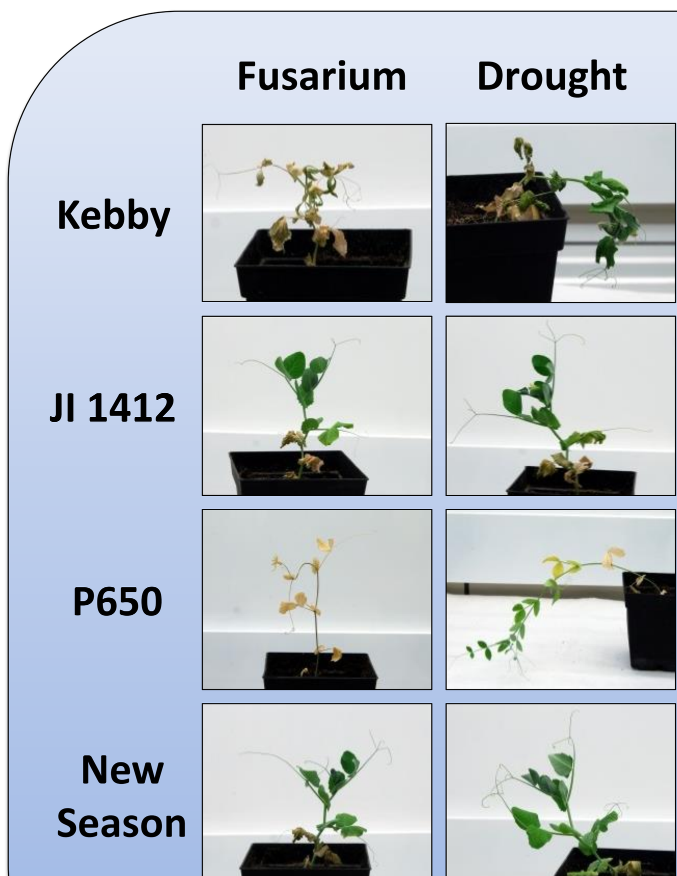


Figure 5. Pea response to *Fop* and/or drought after 15 dpi.

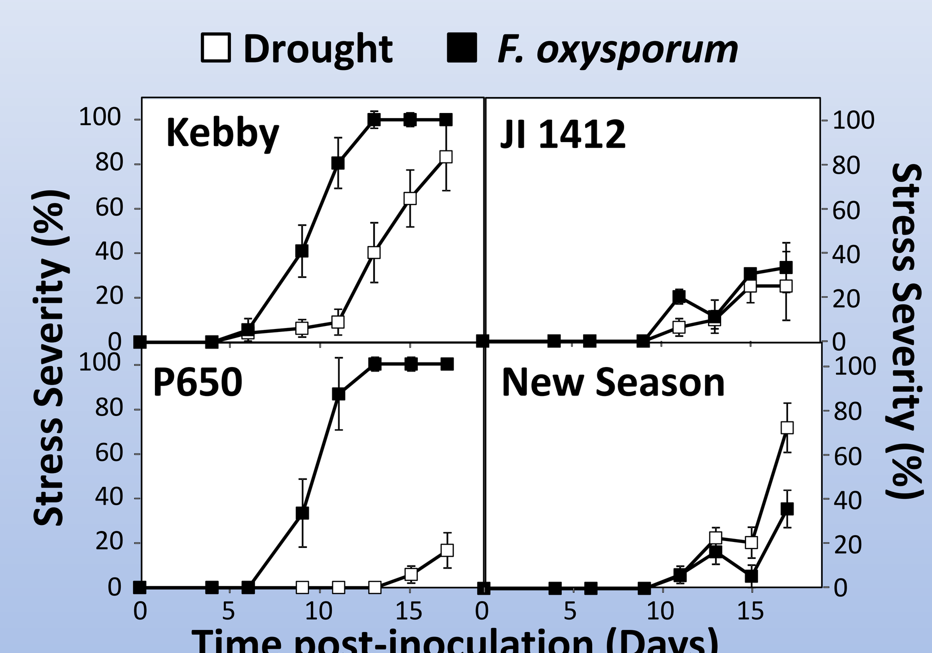


Figure 4. Evolution of drought and *Fop* induced symptoms on four typical pea accesions.

Litterature Cited

(1) Rubiales et al., 2015. Crit Rev Plant Sci 34,195–236
(2) Bani et al., 2012. Plant Pathol 61, 532-542
(3) Ben-Yephet and Shtienberg , 1997. Phytoparasitica 25, 207-216
(4) Rispail et al., 2015. Crop Past Sci 66, 506–515

Fundings

❖Spanish project AGL2014-52871-R

❖NR is holder of a Ramón y Cajal postdoctoral position from the Spanish Ministry of Economy and Competitiveness