Field Screening of Bread Wheat and Barley Germplasm for Resistance to Some Fungal Diseases in the Kef Semi-Arid Area of Tunisia

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Abstract

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Thirteen bread wheat (*Triticum aestivum* L.) and 25 barley (*Hordeum vulgare* L.) lines obtained from the International Center for Agricultural Research in the Dry Areas (ICARDA) germplasm pools were evaluated for their resistance to some fungal diseases under the semi-arid conditions of Kef area in northwest of Tunisia. When bread wheat was inoculated with the common bunt pathogen (*Tilletia laevis* Kuhn), the most resistant were lines 5 and 6 having a mean of 1 % of bunted spikes. The 25 lines of barley inoculated with the covered smut pathogen (*Ustilago segetum* (Pers.) Ditmar) did not show smutted spikes. Based on natural infection of barley, lines 20, 23, and 25 were resistant to net blotch, 2 and 5 to powdery mildew, and 1, 5, 16, and 18 to scald. When the overall resistance to those foliar diseases was evaluated, line 1 was the best, followed by lines 9, 10, and 18.

Key words: Bread wheat, barley, disease resistance, selection, Tunisia.

Introduction

Disease damage is a threat to crop production in the whole world. In Tunisia, diseases and drought are the most important constraints limiting the production of rainfed cereals.

A broad genetic base is a key element for any crop improvement process and must be available in order to enhance yield. Commercially acceptable cultivars can be bred from introduced genetic resources. The evaluation of such a germplasm is therefore essential to identify desirable traits. For this purpose, some lines of bread wheat and barley from the International Center for Agricultural Research in the Dry Areas (ICARDA) germplasm pools were tested for their reaction to fungal diseases under the semi-arid conditions of the Tunisian Kef area. This region is characterized by a Mediterranean climate with an average annual precipitation of 350-400 mm (5).

Materials and Methods

Germplasm

Thirteen bread wheat (Figure 2) and 25 barley lines (Figure 3) from ICARDA germplasm pools were tested for resistance to wheat common bunt and barley covered smut following artificial inoculation. The evaluation was extended to fungal diseases that naturally occur during the study.

Fungal pathogens

Two fungal pathogens were artificially inoculated to bread wheat and barley seeds using teliospore inoculum at the rate of 20 g/kg. *Tilletia leavis* Kuhn (syn *Tilletia foetida* (Wallr.) Liro.) (6) collected from wheat bunted spikes in the Experimental Station of *Ecole Supérieure d'Agriculture du Kef* (Tunisia) was inoculated to 13 bread wheat lines ; *T. laevis* Kuhn is the most important bunt fungal species in Tunisia (7) compared to *T. tritici* (Bjerk.) Wolf (syn *T. caries* (DC.) Tul.) (6). *Ustilago segetum* (Pers.) Ditmar (syn *Ustilago hordei* (Pers.) Lagerh) (13) collected from the northwest of Tunisia was inoculated to 25 barley lines.

Naturally occurring fungal diseases were observed only on barley. They were net blotch caused by *Pyrenophora teres* Drechsler (anamorph *Drechslera teres* (Sacc.) Shoemaker) (2), powdery mildew caused by *Erysiphe graminis* DC. Ex Mérat (anamorph *Oidium monilioides* Link.) (3), and scald caused by *Rhynchosporium secalis* (Oudem.) J. J. Davis (9).

All the fungal pathogens mentioned above were observed and described earlier in Tunisia (8).

Field experiments

The bread wheat and barley lines were investigated in this preliminary trial for their disease resistance under the rainfed conditions of the Kef semi-arid region in Tunisia during three cropping seasons 1997/98, 1998/99, and 1999/00. The monthly mean temperature was more or less similar over the three years, but monthly rainfall was highly variable within and between years (Fig. 1). Experiments were conducted at the Experimental Station of *Ecole Supérieure d'Agriculture du Kef* in 1 m long plots (1, 12) of two rows in the first year and four rows in the second and third years.

Inoculated seeds were planted at the rate of 100 kg/ha during the second half of November and spikes were harvested late May for barley and early June for bread wheat.

Barley foliar diseases were evaluated at the heading stage using the 0-9 scale (10). Bread wheat common bunt and barley covered smut diseases were evaluated by the percentage of diseased spikes at the grain maturity stage. When infection level was equal or less than 5 %, the line was considered resistant.

Results

Bread wheat bunt disease

The evaluation of bread wheat lines for their reaction to bunt disease revealed high resistance of lines 5 and 6 with only 1 % of bunted spikes (Figure 2). Lines 2, 3, 4, and 8 were less resistant (around 10 to 20 %) with high variability. All other remaining lines were susceptible to highly susceptible (mean of bunted spikes between 30 and 50 %).

Barley diseases

During the three cropping seasons, no barley smutted spikes (covered smut) were observed in all tested lines, even though their seeds were artificially inoculated. The most resistant barley lines to net blotch were lines 20, 23, and 25. Their average infection severity were close to 1 (on scale 0-

9). All other lines were less resistant (Figure 3). The average reaction of barley lines to powdery mildew ranged between 2 and 5 (on scale 0-9). The most resistant were lines 2 and 5 and the most susceptible were lines 6, 20, 23, 24, and 25 (Figure 3). Some barley lines were lightly infected with scald with mean infection severity less than 1 (on scale 0-9). These were lines 1, 5, 16, and 18. However, lines 4, 6, 11, 12, 13, 15, and 25 were susceptible. Their mean infection severity ranged between 3 and 5. The remaining lines had intermediate reaction (Figure 3). Results reported in Fig. 4 describe the overall reaction of barley lines to the three observed foliar diseases (net blotch, powdery mildew, scald). Among all, line 1 had the highest overall resistance, followed by lines 9, 10, and 18, with an average of infection severity less than 3 (on scale 0-9). All the remaining lines appeared to be less resistant.

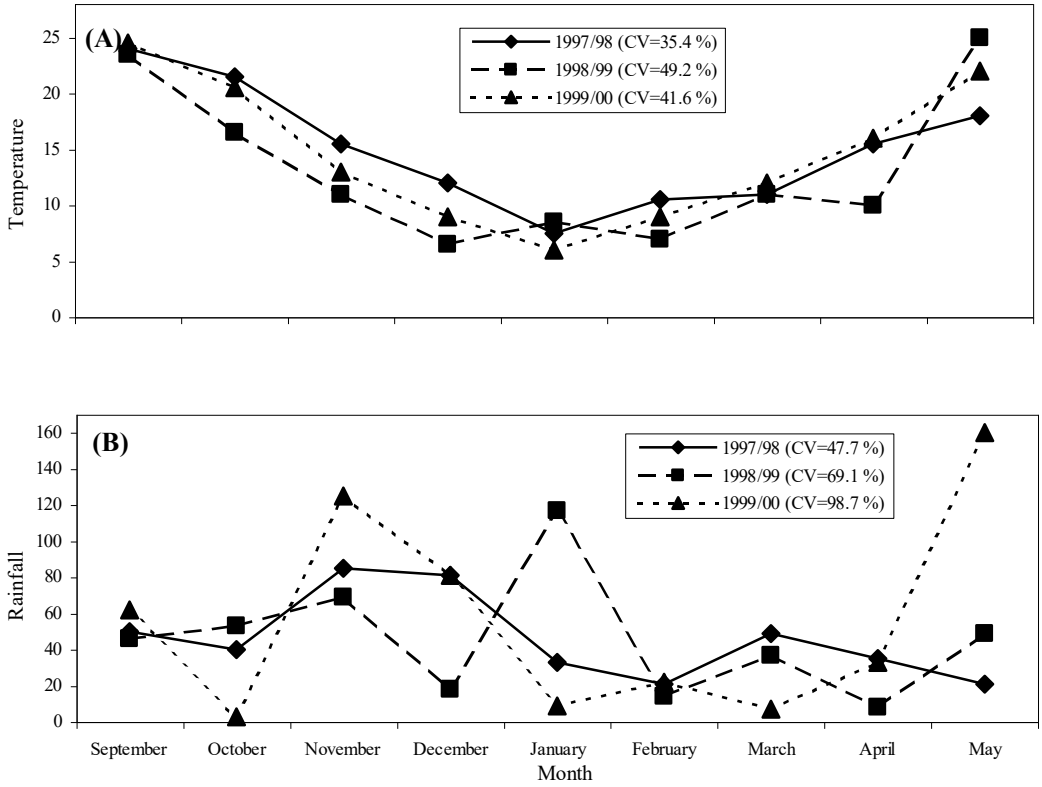

Figure 1. Monthly mean temperature (A) and total rainfall (B) at the experimental site during three cropping seasons (CV: coefficient of variation)

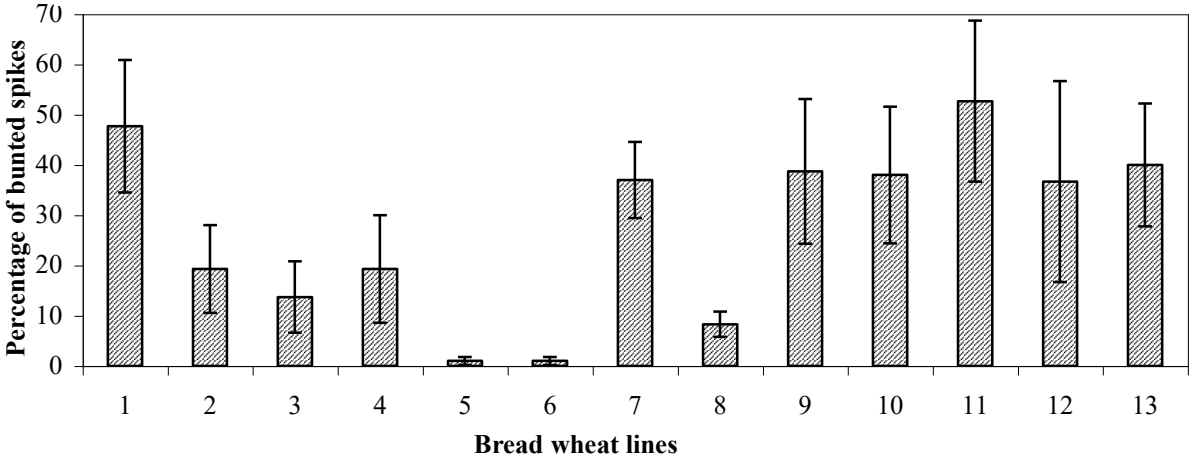

Figure 2. Reaction of the bread wheat lines to common bunt across three years (I : 2 x Standard deviation)

Pedigree of bread wheat lines: 1= 71St2959/Crow'S' (SWM11623-2Y-0Y-1AP-0AP), 2= Wal/3/1154/45//Wal/Su92/4Sol (CM46654-1AP-1AP-2AP-0AP), 3= 4-22/Skp35//C126-15/C74-6/5/Chambord5133//Mt/3/Kkc/4/Lfn//ND/2*P101 (ICW81-1630-1AP-9AP-0AP), 4= Tast/Torim (SWM754397*-02P-3H-1H-0P), 5= 5S1744/Mex67-1//2897/2800 (YE2199-3-2-0E), 6= Lram/4/Mrs//Kal/Bb/3/Azt (ICW-HA81-2108-1AP-2AP-1AP-0AP), 7= Absolvent/4/Mrs//Kal/Bb/3/Azt (ICW-HA81-2213-3AP-1AP-2AP-0AP), 8= Hys//Drc*2/7C (SWM72394-4H-1H-1P-S), 9= Dj/Bza//Woa (II5204-2P-1H-0P), 10= Rbs/Anza/3/Kvz/Hys//Ymg/Tob (SWO73089-98-2H-1H-1H-0P), 11= Las58/Las55///Ald/3/Mrng/4/Ald /Las58.1034//Ald (CM55517-B-1F-701Y-1F-707Y-1F-0Y), 12= RmnF3-71/Torim (SWM765704-11P-2H-3P-0P), 13= Rbs/Anza/3/Kvz/Hys//Ymh/Tob/4/Bow (SWM11625-2AP-1AP-1AP-1AP-0AP).

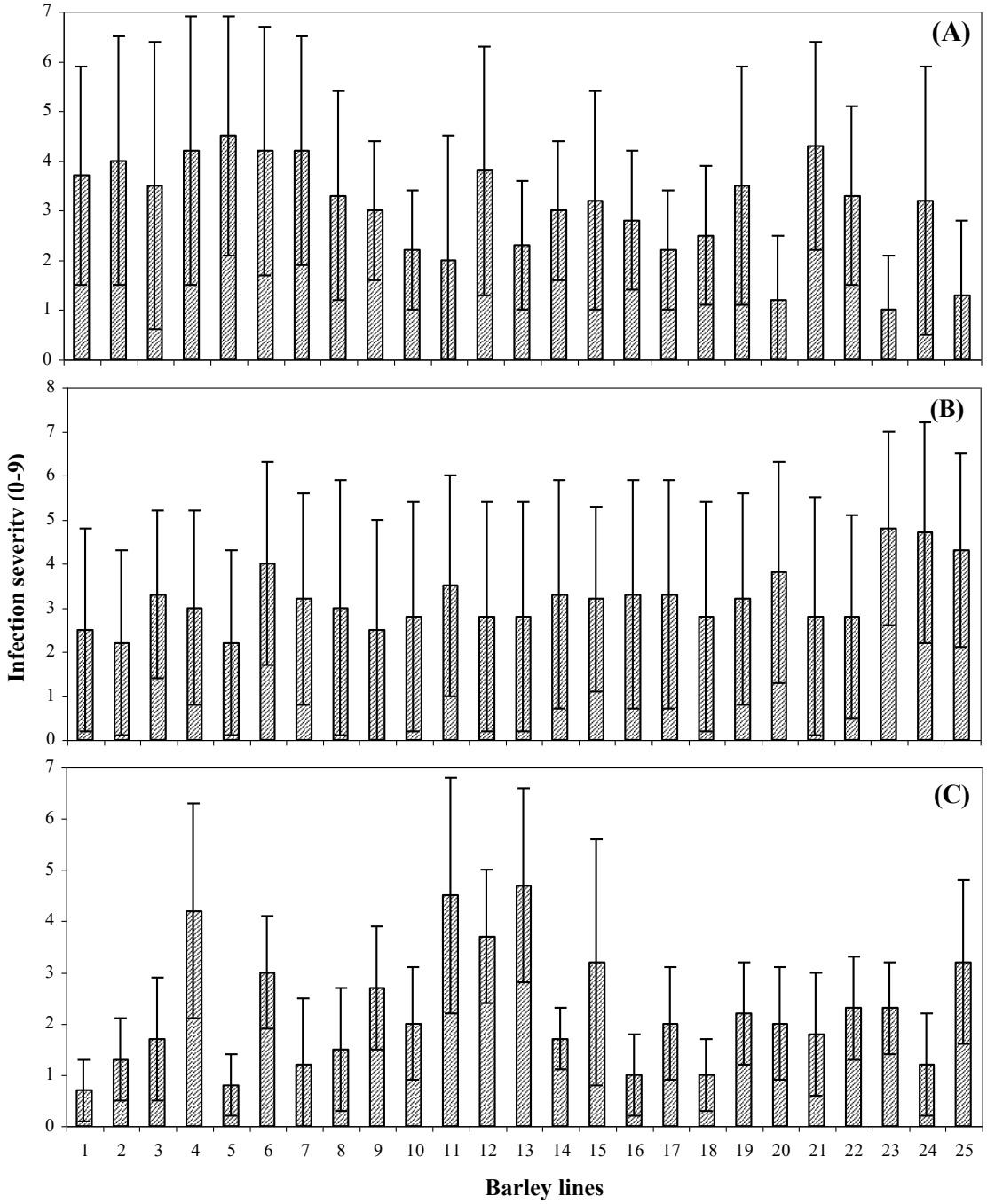

Figure 3. Reaction of barley lines to net blotch (A), powdery mildew (B), and scald (C) across three years (I: 2 x Standard deviation)

Pedigree of barley lines: 1= 80-5145//Giza121/Pue (ICB88-1156-16AP-0AP-6AP-0TR-0AP), 2= Alpha/Arar (ICB88-1136-10AP-0AP-3AP-0AP), 3= Arar/Lignee527 (ICB85-0625-6AP-6AP-2AP-2AP-1APH-0TR-0AP-3AP-0TR-OAP), 4= Arar/Rihane-03 (ICB85-0624-3AP-5AP-0TR-5AP-0TR-0AP-0AP-3AP-0TR-OAP), 5= Arizona5908/Aths/Lignee640/4/Arizona5908 /Aths//Asse/3/F208-74 (ICB89-0841-4LAP-3AP-0TR-0AP), 6= As46/Aths (ICB86-0516-10AP-0TR-3AP-0TR-0AP), 7= As46/Aths*2//WI2197//Arabische (ICB88-0293-1AP-0TR-4AP-0AP-11AP-0TR-0AP), 8= As46/Aths*2/5/CI01021/4/CM67/ U.Sask.1800//Pro/CM67/3/DL70 (ICB89-0278-1AP-1AP-1AP-0TR-0AP), 9= As46/Aths*2/5/CI01021 /4/CM67/U.Sask.1800//Pro/CM67/3/DL70 (ICB89-0278-1AP-1AP-3AP-0TR-0AP), 10= As46/Pro//Bal.16/Api/4/11012-2/Tern//H252/3/Nopal'S'/5/Assala (ICB82-0172-2AP-0AP-0AP-36AP-0TR), 11= Chaaran01/3/ Arizona 5908/Aths//Bgs/4/Ager//Api/CM67/3/Cel/W12269//Ore (ICB89-0799-4AP-1AP-2AP-0TR-0AP), 12= Chaaran-01/WI2291/5/Caco'S' /3/Api/CM67// 1594/4/PI382934 (ICB91-0110-0AP-0AP-0AP), 13= Cr.115/Pro//Bc/3/Api/cm67/4/Giza120/5/Satter2/Namur (ICB85-1058-3AP-3AP-0TR-3AP-0TR-0AP-0AP-1AP-0TR-OAP), 14= DeirAlla106/Cel/3/NpBarley/6307//Ch-Du (ICB88-0724-1LAP-1APH -1APH-3AP-0TR-0AP), 15= DeirAlla106/Cel/S/Cr.115/Pro//Bc /3/Api/CM67/3/Giza120 (ICB83-0211-0AP-3AP-0TR-0AP), 16= M64-76/Ben//Jo/York/3/M5/Galt//As46/4/Hj34-80/Astrix/5/M6/Robur35-6-3 (ICB88-1391-15AP-0AP-1AP-0TR-0AP), 17= Mo.B 1337/WI2291//Zanbaka (ICB91-0481-0AP-0AP-0AP), 18= Roho (-), 19= Rihane-03/3/Roho//Alger/Ceres.362-1-1 (ICB85-0405-3AP-1AP-0TR-2AP-0TR-0AP), 20= Rihane-03/3/Roho//Alger/Ceres.362-1-1 (ICB85-0405-3AP-5AP-0TR-1AP-0TR-0AP), 21= SLB34-65/Arar (ICB88-0043-16AP-0AP-4AP-0AP), 22= Salmas/WI2269*2 (ICB86-0457-1AP-3AP-1TR-1AP-0TR-0AP), 23= UC566/5/M64-76/Bon//Jo/York/ 3/M5/Galt//As46/4/Hj34-80/Astrix (ICB83-1818-2AP-1AP-5AP-7AP-4AP-0TR-0AP-2AP-0TR-OAP), 24= UC566/ 5/M64-76/Bon//Jo/York/3/M5/Galt//As46/4 /Hj34-80/Astrix (ICB83-1818-2AP-1AP-5AP-7AP-4AP-0TR-0AP-4AP-0TR-OAP), 25= UC566/5/M64-76/Bon//Jo/York/3/M5/Galt//As46/4/Hj34-80/Astrix (ICB83-1818-2AP-1AP-5AP-7AP-4AP-0TR-0AP-5AP-0TR-OAP).

Discussion

In this study carried out in Kef area of Tunisia, the superiority of some introduced lines with regard to their disease resistance was confirmed. Bread wheat lines 5 and 6 with only 1 % of their spikes being bunted, could be considered as an important source of resistance to common bunt. However, all barley lines were smut free which makes them a promising germplasm for potential use by cereal breders (1).

Using a more conservative level of selection than often utilized (4, 11) for barley foliar diseases, the most resistant were lines 20, 23, and 25 to net blotch, 2 and 5 to powdery mildew, and 1, 5, 16, and 18 to scald (Figure 3). Concerning the overall reaction to those barley foliar diseases, the most resistant was line 1, followed closely by lines 9, 10, and 18 (Figure 4). The above results suggest that for practical purposes, breeders have the choice of a smut resistant line which is also resistant to one or more foliar diseases.

Acknowledgements

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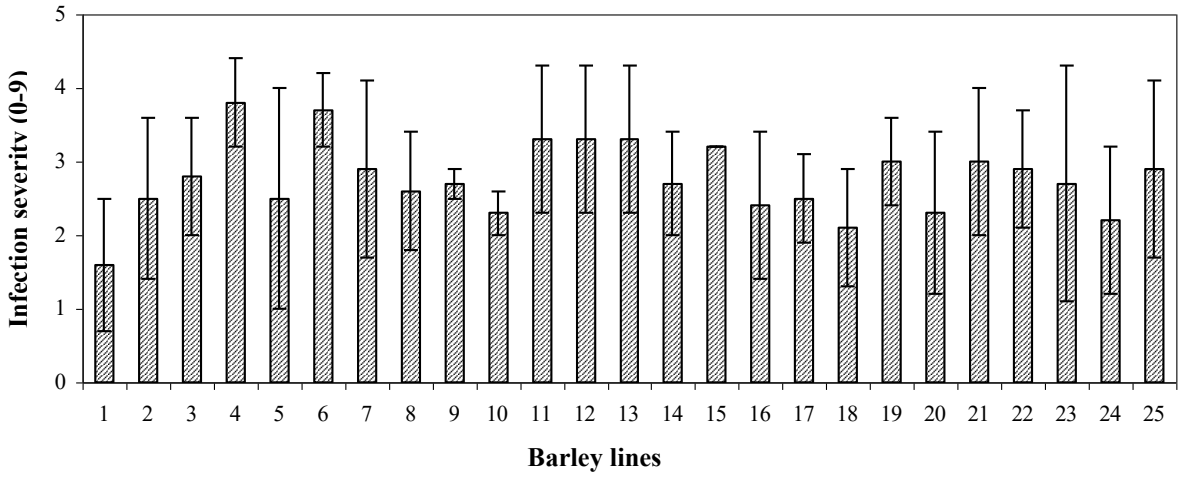

Figure 4. Overall reaction of barley lines to net blotch, powdery mildew, and scald across three years (I: 2x Standard error)

الملخص

نصراوي، بوزيد ومنصف بنحمودة ومحسن بوبكر وألفة بن سالم ويوتاكا شيباياما. 2003. تقييم حقلي لمقاومة أصول وراثية من القمح الطري والشّعير لبعض الأمراض الفطرية في منطقة الكاف شبه الجافّة التّونسية. مجلة وقاية النبات العربية. 21: 166–170.

تم تقويم 13 سلالة من القمح الطري (*Triticum aestivum* L.) و25 سلالة من الشعير (*Hordeum vulgare* L.) من أصول وراثية تم الحصول عليها من المركز الدّولي للبحوث الزّراعية في المناطق الجافة (ايكاردا) ضدّ بعض الأمراض الفطرية تحت ظروف شبه جافة لمنطقة الكاف بالشمال الغربي التونسي. وعندما تم القاح القمح الطري بالفطر المسبّب لمرض التفحم المغطّى (*Tilletia laevis* Kuhn)، تبيّن أنّ السّلالتين 5 و 6 هما الأكثر مقاومة بمعدل 1% من السّنابل المتفحّمة. وعندما تم إلقاح كل سلالات الشعير بالفطر المسبب للتفحم المغطى (*Ustilago segetum* (Pers.) Ditmar) كانت كلها مقاومة جداً لهذا المرض (غياب تام للسنابل المتفحمة). عقب الإصابة الطبيعية للشعير، تبين أن أفضل السلالات مقاومة هي 20 و23 و25 للتبقع الشبكي، 2 و5 للبياض الدقيقي، 1 و5 و16 و18 للسعة. أما عند تقويم المقاومة العامّة لكل هذه الأمراض الورقية، كانت سلالة الشعير 1 هي الأفضل، يليها السلالات 9 و10 و18.

كلمات مفتاحية: قمح طري، شعير، مقاومة الأمراض، انتخاب، تونس.

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