Chemical Program for the Control of Barley Foliar Diseases in Tunisia

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Abstract


A field experiment to control scald (Rhychosporium secalis (Oudem) J. J. Davis), net blotch (Pyrephonora teres Drechsler), and powdery mildew (Erysiphe graminis DC ex Merat) of barley (Hordeum vulgare L.) with pesticides was conducted in a Northern semi-arid area of Tunisia (Kef). The effectiveness of seminotherapy, a seed treatment to control barley foliar diseases, and foliar spray with a fungicide-herbicide mixture at the tillering stage, was tested. The pesticides used were Vinicit F or Real 200 (fungicides) for seminotherapy and a mix of Horizon, Impact, Opus, or Punch C (fungicides) with Illoxan Super New + Granstar (herbicide) for foliar treatment. Results indicated that Vinicit F or Real 200 protected barley several weeks after emergence whereas the mixture of one fungicide with the herbicide gave protection starting from the tillering stage. The effectiveness of the herbicide, mixed or not with one fungicide, was the same. Therefore, to control barley foliar diseases under Tunisian conditions, it is recommended first to apply seminotherapy for the protection of barley from early infections during the winter and secondly to apply foliar treatment with a fungicide-herbicide mix to protect barley from the infection spreading during the spring. Hence, the seminotherapy would help protect plants to grow vigorously and the single combined foliar treatment would prevent an extra physical damage of the crop and reduce the cost of production.

Key words: Barley, scald, net blotch, powdery mildew, chemical control, Tunisia.

Introduction

Barley is one of the most important cereal crop in semi-arid areas of Tunisia, where production is affected by stresses of drought in dry years, and fungal diseases in rainy years. Among such diseases, scald, net blotch, and powdery mildew are considered as major diseases stress limiting barley cropping in the country (13). They break out under favorable conditions and frequently cause barley yield losses. Chemical control of these diseases is an important pest management component adopted by farmers (12) since highly resistant barley germplasm is not yet available.

During more than a decade, seed treatment started to be applied for the control of fungal pathogens attacking cereals after emergence, in addition to those which are seed-borne. Numerous fungicides such as carboxin, flutriafol, penconazole, thiabendazole, triadimenol, triadimenol, and triazole have been tested and most of them proved to be effective against barley foliar diseases that are seed-borne (scald and net blotch) or air borne (powdery mildew) (6, 7, 10, 11, 17). Applying seed treatment to control wheat rusts which are not seed-borne diseases, some researchers introduced in 1993 the term ‘seminotherapy’ to distinguish between the new approach and the classical concept of seed treatment (2). In Tunisia, seminotherapy using triticonazole 20 % (Real 200 at the dose of 500 ml/q) gave good results in the control of some barley foliar diseases (12). However, this fungicide can not be recommended to farmers in the Tunisian context because of its high price. An alternative was proposed by some research workers and consists of applying seminotherapy through high doses (3 to 5 folds) of common fungicides normally used in the old concept of seed treatment to control seed-borne diseases. Among different tested fungicides, flutriafol 2.5 % + thiabendazole 2.5 % (Vinici F) was selected (12).

To control both fungal diseases and weeds, fungicides and herbicides may be mixed without loosing their effectiveness. In the case of cereal diseases such as net blotch and powdery mildew, herbicides were mixed with the fungicides trizone, triadimenol, or propiconazole (3, 9). In Tunisia, some fungicide-herbicide combinations have been used and were found to be effective against barley and wheat foliar diseases (12, 14). The low cost of production and the prevention of an additional flattening down of the crop can justify this approach of combined foliar treatment.

On the basis of seminotherapy coupled with combined foliar treatment, a new chemical program for the control of barley foliar diseases was tested under the Tunisian conditions where most farmers afford usually only one field mechanical treatment on their cereals during one cropping season.

Materials and Methods

Biological Material

The experiment was conducted in a Northern semi-arid area of Tunisia (Experimental Station of Higher School of Agriculture of Kef) during the 2002/2003 growing season. ‘Rihane’, a barley (Hordeum vulgare L.) variety, was used to study its natural infection by scald, net blotch, and powdery mildew diseases caused by Rhychosporium secalis (Oudem) J.J. Davis, Pyrephonora teres Drechsler (anamorph Drechslera teres (Sacc.) Shoemaker), and Erysiphe graminis DC ex Merat (anamorph Oidium moniliforme Link), respectively. The fungi and the diseases were described by many authors (4, 5, 8, 15, 18). In Tunisia, those barley diseases were observed and described by different researchers (13).

Pesticides

Seminotherapy - Two fungicides were used for seed treatment. The first is triticonazole 20 % (Real 200 at the dose of 500 ml/q) used as reference fungicide known for its high effectiveness (10, 11, 12), but its cost is high in Tunisia. The second is Flutriafol 2.5 % + thiabendazole 2.5 % (Vinici F at the dose of 800 ml/q) which has been shown to be effective against some cereal diseases in Tunisia for several weeks after emergence, when using 3 folds (or more) the normal dose of 200 ml/q (12). The fungicide Vinici F, composed of a triazole (flutriafol) and a benzimidazol (thiabendazole), is classified non toxic (1) and consequently the high doses have no side effect on the soil environment.
**Combined foliar treatment** - In Tunisia, a unique chemical foliar treatment with a mixture of fungicides and herbicides has been shown to ensure satisfactory control of different barley and wheat diseases (12, 14). In this experiment, four fungicides were selected to be tested mixed with one herbicide. The selected fungicides are:

- Epoxiconazole 12.5 % (Opus at the dose of 1 l/ha),
- Flusilazole 25 % + carbenazim 12.5 % (Punch C at the dose of 1 l/ha),
- Flutriafol 12.5 % (Impact at the dose of 1 l/ha),
- Tebuconazole 25 % (Horizon at the dose of 1 l/ha).

The herbicide to be mixed with each fungicide is one of the most commonly used pesticide by the Tunisian farmers. It is composed of Dichlofop-methyl 25 % + fenoxaprop-p-ethyl 2.3 % (Illinox Super at the dose of 2 l/ha) + Tribenuron-methyl 75 % (Granstar at the dose of 20 g/ha). Illinox Super and Granstar are anti-monocotyledonous and anti-dicotyledonous, respectively.

**Experimental design**

The experiment was performed in Randomized Complete Block Design with 4 replications. Six row plots (1.2 m x 5 m) received the following treatments:

- **H:** only Herbicide foliar treatment as control (no antifungal treatment),
- **V + H:** semiotherapy with Vincit F and foliar treatment with a mixture of Horizon and the herbicide,
- **V + I:** semiotherapy with Vincit F and foliar treatment with a mixture of Impact and the herbicide,
- **V + O:** semiotherapy with Vincit F and foliar treatment with a mixture of Opus and the herbicide,
- **V + P:** semiotherapy with Vincit F and foliar treatment with a mixture of Punch C and the herbicide,
- **R + H:** semiotherapy with Real 200 and foliar treatment with a mixture of Horizon and the herbicide,
- **R + I:** semiotherapy with Real 200 and foliar treatment with a mixture of Impact and the herbicide,
- **R + O:** semiotherapy with Real 200 and foliar treatment with a mixture of Opus and the herbicide,
- **R + P:** semiotherapy with Real 200 and foliar treatment with a mixture of Punch C and the herbicide.

Semiotherapy was performed one week before planting whereas foliar treatment was applied at the tillering stage. Standard cultural practices for barley in the area were applied.

**Disease and weed evaluation**

To evaluate the effect of the semiotherapy, disease severity of the early infection during winter was recorded at the tillering stage, using an arbitrary 0-4 severity scale (0 = no symptoms, 1 = light infection of first leaves, 2 = heavy infection of first leaves and light infection of second leaves, 3 = heavy infection of first and second leaves and light infection of third leaves, 4 = infection of all leaves). At the same time, the incidence of every disease was estimated by the percentage of infected plants in each plot (from 0 to 100%). Both results were then expressed in an infection degree = severity x incidence (0-400 scale).

For the assessment of the foliar treatment effect, the development of the infection during spring was evaluated at the late heading stage according to the common 0—9 severity scale (16). The incidence (0 to 100 %) was also estimated in each plot and the infection degree (severity x incidence) was expressed according a 0—900 scale.

At the late heading stage, the herbicide effect was also evaluated through the number of weeds per square meter in each plot.

Finally, for every barley plot, the thousand grain weight was measured and the grain yield was reported in quintals per hectare.

**Results**

**Semiotherapy**

Scald, net blotch, and powdery mildew disease evaluation at barley tillering stage showed a highly significant difference between treated seeds by Vincit F or Real 200 and the non treated control (Fig. 1). The infection degree levels for all diseases were between 130 and 170 (on the 0—400 scale) for the control, whereas with the treated seeds, they were generally less than 80.

![Figure 1. Effect of semiotherapy on scald, net blotch, and powdery mildew development in barley at the tillering stage (LSD = 14.3, 15.9, and 15.5, for the three disease, respectively)](image)

**Combined foliar treatment**

**Disease assessment** - Without fungicide foliar treatment, scald and net blotch observed on barley at the late heading stage (Table 1), showed an infection degree levels over 700 (on the 0—900 scale). Powdery mildew was not assessed because it highly regressed. On the other hand, foliar treatment by all fungicides (Horizon, Impact, Opus, or Punch C) mixed with the herbicide at the tillering stage, reduced the infection degree to around 100 for scald and to around 200 for net blotch. The difference between foliar and no foliar chemical treatments was highly significant.
Table 1. Effect of chemical treatment on foliar disease infection, weed infestation and barley grain production.

<table>
<thead>
<tr>
<th>Chemical treatment</th>
<th>Infection degree (0-900) at late heading stage</th>
<th>Weed infestation (plants/m²) at late heading stage</th>
<th>Thousand grain weight (g)</th>
<th>Grain yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seald</td>
<td>Net blotch</td>
<td>157 a</td>
<td>42.1 b</td>
</tr>
<tr>
<td>Herbicide</td>
<td>754.5 a</td>
<td>732.5 a</td>
<td>157 a</td>
<td>42.1 b</td>
</tr>
<tr>
<td>Vincit + Horizon + Herbicide</td>
<td>122.5 b</td>
<td>203.8 b</td>
<td>133 a</td>
<td>45.1 a</td>
</tr>
<tr>
<td>Vinct + Impact + Herbicide</td>
<td>170.0 b</td>
<td>272.5 b</td>
<td>129 a</td>
<td>44.9 a</td>
</tr>
<tr>
<td>Vinct + Opus + Herbicide</td>
<td>73.8 b</td>
<td>231.3 b</td>
<td>128 a</td>
<td>44.4 a</td>
</tr>
<tr>
<td>Vinct + Punch C + Herbicide</td>
<td>86.3 b</td>
<td>182.5 b</td>
<td>139 a</td>
<td>43.6 ab</td>
</tr>
<tr>
<td>Real 200 + Horizon + Herbicide</td>
<td>92.5 b</td>
<td>187.5 b</td>
<td>138 a</td>
<td>43.7 ab</td>
</tr>
<tr>
<td>Real 200 + Impact + Herbicide</td>
<td>183.8 b</td>
<td>231.3 b</td>
<td>132 a</td>
<td>43.9 ab</td>
</tr>
<tr>
<td>Real 200 + Opus + Herbicide</td>
<td>122.5 b</td>
<td>191.3 b</td>
<td>135 a</td>
<td>43.5 ab</td>
</tr>
<tr>
<td>Real 200 + Punch C + Herbicide</td>
<td>156.3 b</td>
<td>178.8 b</td>
<td>139 a</td>
<td>44.3 a</td>
</tr>
<tr>
<td>LSD at 5 %</td>
<td>104.7</td>
<td>122.7</td>
<td>26.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

* In each column, numbers followed by the same letter are not significantly different at \( P = 0.05 \)

**Weed assessment** - Barley infestation by weeds was also evaluated at the late heading stage (Table 1). No significant difference was observed between the use of the herbicide alone as a control and the use of the herbicide mixed with one of the fungicides (Horizon, Impact, Opus, or Punch C). In all cases, the number of plants per square meter was between 120 and 140.

**Thousand grain weight**

Comparison of the thousand barley grain weight showed that the non-treated control with fungicides had the lowest weight, around 42 g (Table 1). With chemical control (seleniumity coupled with foliar treatment), this weight was between 43.5 and 45 g, with no significant differences between treatments. Half of the chemically treated cases were significantly different from the non treated control.

**Grain production**

Barley grain yields related to the different chemical treatments were compared (Table 1). Lower yield was obtained with the non-treated control (around 37 q/ha). In contrast, chemical control (seleniumity coupled with foliar treatment) allowed an increase of more than 6 q/ha for all treatments. In one treatment (Vincit F and Punch C in seleniumity and in foliar treatment, respectively), the difference with the control was statistically significant.

**Discussion**

Seleniumity (seed treatment against seed-borne and non seed-borne diseases) applied to control barley foliar diseases gave results in agreement with those in previous studies (6, 7, 10, 11, 12, 17). Therefore, seleniumity highly protected barley from early infections by foliar diseases, such as scald, net blotch, and powdery mildew, which generally occur during the winter in Tunisia (Fig. 1).

Foliar treatment of barley with a fungicide-herbicide combination led to results similar to those of previous workers (3, 9, 12). Every tested fungicide (Horizon, Impact, Opus, or Punch C), mixed with the herbicide, highly protected barley plants against the spread of foliar diseases during the spring (Table 1). These fungicides would have the same effect if they were used individually as it was previously reported with different fungicides (12, 14). On the other hand, the herbicide used for the control of weeds was as effective alone as when it was mixed with one fungicide (Table 1). In all experiments, no phytotoxicity signs were observed.

Though the fungicide effects on the barley thousand grain weight and on grain yield were not always statistically significant, the non treated control gave the lowest values (Table 1). Hence, barley production was generally increased by the application of the chemical treatments.

The overall results support the adoption of a new chemical program to control Foliar diseases of barley in the Tunisian – and probably in the North-African – context. It would consist of a first treatment using seleniumity to protect barley against the early infections during the winter and to help therefore plants to grow vigorously. Then, a second treatment with a mixture of fungicide-herbicide at the tillering stage would slow down the infection development during the spring in order to save the last three leaves. Besides its effectiveness, this second treatment would reduce the production cost since only one operation, instead of two, has to be made to control both diseases and weeds. In addition, the second operation that causes physical damage to barley plants during stem elongations eliminated. Hence, this technical itinerary would be easily adopted by Tunisian farmers who generally accept early weeding, but usually are unfavorable for late mechanical field operations at pre-heading stage.
المختص

نصراوي، بوزيد. الهادي، منصور، سمير، عزيزي، ويوسف، شمالي. 2004. برنامج كيميائي لمكافحة الأمراض الورقية للشجر في تونس. مجلة وفية الناس العربية. 22: 159-162.

References


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