Chemical Program for the Control of Barley Foliar Diseases in Tunisia

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Abstract

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A field experiment to control scald (*Rhynchosporium secalis* (Oudem) J. J. Davis), net blotch (*Pyreonphora 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 foliar diseases, and foliar spray with a fungicide-herbicide mixture at the tillering stage, was tested. The pesticides used were Vincit 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 Vincit 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 protecte 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, triadimefon, triadimenol, and triticonazole 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, flutirafol 2.5 % + thiabendazole 2.5 % (Vincit 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 triforine, triadimefon, 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 *Rhynchosporium secalis* (Oudem) J.J. Davis, *Pyrenophora teres* Drechsler (anamorph *Drechslera teres* (Sacc.) Shoemaker), and *Erysiphe graminis* DC ex Merat (anamorph *Oidium monilioides* 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 - Tow 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 % (Vincit 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 Vincit F, composed of a triazole (flutriafol) and a benzimidazole (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 % + carbendazim 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-ethtyl 2.3 % (Illoxan Super at the dose of 2 l/ha) + Tribenuron-methyl 75 % (Granstar at the dose of 20 g/ha). Illoxan Super and Granstar are anti-monocotyledons and anti-dicotyledons, respectively.

Experimental design

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

- Hr: only Herbicide foliar treatment as control (no anti-fungal treatment),
- V + HHr: seminotherapy with Vincit F and foliar treatment with a mixture of Horizon and the herbicide,
- V + IHr: seminotherapy with Vincit F and foliar treatment with a mixture of Impact and the herbicide,
- V + OHr: seminotherapy with Vincit F and foliar treatment with a mixture of Opus and the herbicide,
- V + PHr: seminotherapy with Vincit F and foliar treatment with a mixture of Punch C and the herbicide.
- R + HHr: seminotherapy with Real 200 and foliar treatment with a mixture of Horizon and the herbicide,
- R + IHr: seminotherapy with Real 200 and foliar treatment with a mixture of Impact and the herbicide,
- R + OHr: seminotherapy with Real 200 and foliar treatment with a mixture of Opus and the herbicide,
- R + PHr: seminotherapy with Real 200 and foliar treatment with a mixture of Punch C and the herbicide.

Seminotherapy 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 seminotherapy, 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

Seminotherapy

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.

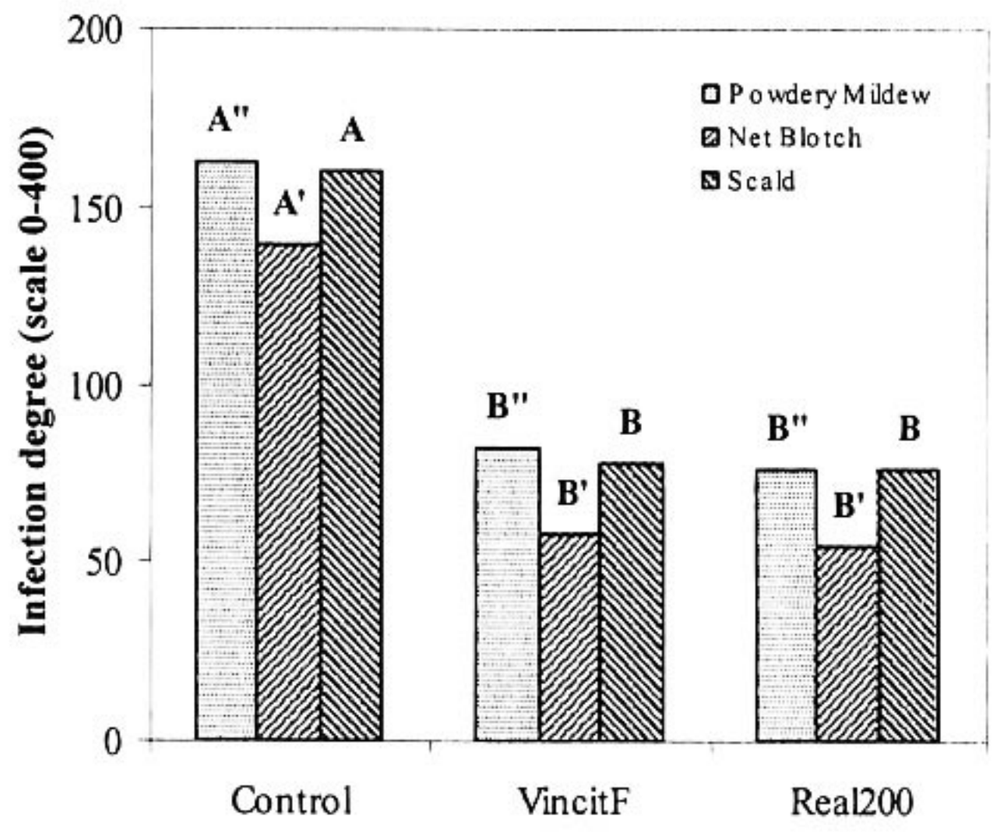

Figure 1. Effect of seminotherapy on scald, net blotch, and powdery mildew development in barley at the tillering stage (LSD = 14.3, 15.9, and 15.5, for the three disease, respectively)

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.

Chemical treatment	Infection degree (0-900) at late heading stage		Weed infestation (plants/m^2) at late heading stage	Thousand grain weight (g)	Grain yield (q/ha)
	Scald	Net blotch			
Herbicide	754.5 a	732.5 a	137 a	42.1 b	37.2 b
Vincit+ Horizon+ Herbicide	122.5 b	203.8 b	133 a	45.1 a	44.9 ab
Vincit + Impact + Herbicide	170.0 b	272.5 b	129 a	44.9 a	46.1 ab
Vincit + Opus + Herbicide	73.8 b	231.3 b	128 a	44.4 a	46.6 ab
Vincit + Punch C + Herbicide	86.3 b	182.5 b	139 a	43.6 ab	48.1 a
Real 200 + Horizon + Herbicide	92.5 b	187.5 b	138 a	43.7 ab	42.8 ab
Real 200 + Impact + Herbicide	183.8 b	231.3 b	132 a	43.9 ab	45.8 ab
Real 200 + Opus + Herbicide	122.5 b	191.3 b	135 a	43.5 ab	43.9 ab
Real 200 + Punch C+ Herbicide	156.3 b	178.8 b	139 a	44.3 a	44.5 ab
LSD at 5 %	104.7	122.7	26.1	2.1	10.6

* 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 (seminotherapy 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 (seminotherapy 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 seminotherapy and in foliar treatment, respectively), the difference with the control was statistically significant.

Discussion

Seminotherapy (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, seminotherapy 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 seminotherapy 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 elongationis 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.

الملخص

نصراوي، بوزيد، الهادي منصوري، سمير عيدودي ويوتاكا شيبياما. 2004. برنامج كيميائي لمكافحة الأمراض الورقية للشعير في تونس. مجلة وقاية النبات العربية. 22: 159-162.

لمكافحة أمراض السفحة (*Rhynchosporium secalis* (Oudem) J. J. Davis) والتبقع الشبكي (*Pyreonphora teres* Drechsler) والبياض الدقيقي (*Erysiphe graminis* DC ex Merat) على الشعير (*Hordeum vulgare* L.)، أجريت تجربة حقلية للطريقة الكيميائية في منطقة شبه جافة بالشمال الغربي التونسي (الكاف). تم اختبار جدوى 'المعالجة البذرية' (seminotherapy)، وهي طريقة تعتمد على معاملة البذار لمكافحة الأمراض الورقية، وكذلك رش الأوراق بخليط من مبيد فطري مع مبيد عشبي أثناء طور الإشطاء. أما المبيدات المستعملة فكانت كالتالي: فانسيت ف أو ريال 200 (مبيدان فطريان) للمعاملة البذار وخليط من هوريزون أو أمباكت أو أوبوس أو بانش س (مبيدات فطرية) مع إللوكسون سوبار + غرنستار (مبيد عشبي) لرش الأوراق. بينت النتائج أن فانسيت ف أو ريال 200 يحميان الشعير عدة أسابيع بعد الانبثاق بينما أظهر خليط من مبيد فطري مع المبيد عشبي حماية للشعير بدءا من طور الإشطاء. وكان للمبيد العشبي ذات الجدوى سواء استعمل وحده أو مخلوطا مع مبيد فطري. وبهذه النتائج الخاصة بمقاومة الأمراض الورقية للشعير تحت ظروف البيئة التونسية، يمكن التوصية أولا بالمعالجة البذرية لحماية نباتات الشعير من الإصابات المرضية المبكرة أثناء فصل الشتاء، ثم ثانيا رش الأوراق بخليط من مبيد فطري مع مبيد عشبي لحماية الشعير من انتشار الأمراض خلال فصل الربيع. و نتيجة لذلك، يمكن للمعالجة البذرية أن تساعد النباتات المحمية على النمو الجيد، بينما يساعد رش الأوراق مرة واحدة بالخليط على خفض كلفة الإنتاج و تجنب إلحاق ضرر للمزروعات بعدم الدخول ثانية للمداواة.

كلمات مفتاحيه: شعير، سفحة، تبقع شبكي، بياض دقيقي، مقاومة كيميائية، تونس.

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