A new source of resistance to Hessian fly (Diptera: Cecidomyiidae) identified in an Algerian bread wheat collection

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Abstract

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Hessian fly, *Mayetiola destructor* (Say), causes heavy damage on both durum and bread wheats in Morocco Major effort has been put on host plant resistance to control this pest. Field and greenhouse screenings of an Algerian bread wheat collection were carried out in Morocco to look for new sources of resistance to Hessian fly. Results showed that the line ADC14 is moderately resistant to this insect. This is the first source of resistance to Hessian fly in Morocco identified in a North African wheat. The presence of dead first instars on resistant plants indicates that antibiosis is the mechanism responsible for the resistance of ADC14. However, about 18% of the resistant plants had live larvae. The deployment of varieties that allow for larval survival on resistant plants should be encouraged. This type of resistance would reduce selection for biotype development. This new source of resistance is being used by Moroccan breeders in the bread wheat improvement program.

Key Words: *Mayetiola destructor*, *Triticum aestivum*, resistance.

Introduction

The Hessian fly is the major destructive pest of wheat in Morocco. Lhaloui *et al.*, (13) , and Amri *et al.* (1) estimated the bread wheat (*Triticum aestivum L.*) yield losses due to Hessian fly at 42% and 36%, respectively. This insect caused 32% yield losses in durum wheat (*T. turgidum L. var. durum*) (13).

Genetic resistance in wheat has been the most effective and economical means of controlling this pest. In the USA, twenty-six resistance genes designated H1 through H26 have been identified in *Triticum* species and *Secale cereale* L. for use in cultivar improvement (3); more than 50 resistant varieties have been developed (11). Resistance genes have been found to be dominant, partially dominant, or recessive. The mechanism of resistance conditioned by these genes is antibiosis, i.e., first instars die after feeding on resistant plants.

In Morocco, the resistance genes H5, H7H8, H11, H13, H14H15, H21, H22, H23, H25, and H26 are effective against Hessian fly (4, 5, 7). All of these major resistance genes have been incorporated by breeders into adapted Moroccan bread wheat. Two varieties 'Saada' and 'Massira' have been released in 1989 and 1994 (12). Two bread wheat lines, L222 and one carrying H22 gene will be released soon, and should reach the farmer in about two years.

A gene for gene relationship has been demonstrated between resistance in wheat and avirulence in the Hessian fly, with virulence in the insect conditioned by a homozygous recessive pairs of genes (10). As a consequence of this highly specific system between wheat and Hessian fly, eight biotypes have been identified from field populations in the USA and are designated Great Plains (GP), A, B, C, D, E, J, and L (9, 15). In order to stay ahead of the biotype development, entomologists, geneticists, and breeders have to identify new resistance genes and incorporate them into adapted cultivars.

The objective of this study was to find new sources of resistance to Hessian fly in Morocco.

Materials and Methods

Field test

This test was carried out at the Jemaa Shaim experiment station in the 1993/94 growing season. Because of shortage of seed, this test was not replicated. This bread wheat collection that comprises 150 land races was provided by the "Institut Technique des Grandes Cultures (ITGC), station Lakroub, Constantine, Algeria. Entries were planted in single rows (ca. 60 seeds per row) 1 m long with 50 cm between rows. The cultivars saada and Nasma, which were used as resistant and susceptible check respectively, were planted after every 10 entries. When the larvae were in the puparial (flaxseed) stage, all the plants of each entry were collected from the field and taken to the laboratory for examination. Susceptible and resistant plants were separated on the basis of symptoms Susceptible plants were stunted and dark green in color, whereas resistant plants were not stunted, retained their light green color, and contained dead first instars. The number of live and dead larvae were recorded for five randomly selected susceptible and resistant plants.

Growth Chamber Test

In 1993 growing season, a test similar to the field test was conducted in a growth chamber using a heterogeneous avirulent Hessian fly population collected from the Settat region, Morocco. The experimental design was a randomized complete block with four replications. This test included only the line ADC14 that showed a moderate level of resistance in the field; the rest of the collection (149 lines) was discarded because they were all susceptible. Nasma and Saada were used as susceptible and resistant checks, respectively. Methods of infestation and determination of resistance or susceptibility of individual plants were similar to those used by Cartwright and LaHue (2). Seeds were sown in rows (ca. 30 seeds per row) in a standard greenhouse flat (54 x 36 x 8 cm) containing a mixture of soil, vermiculite and peat. Flats containing plants at the one leaf-stage were placed under a cheesecloth tent along with infested plants containing mature pupae of Hessian fly. When adults emerged, females were allowed to lay eggs on the seedlings for two days. Plant reactions to larval feeding were determined 20 days after egg hatch. The method of evaluation was similar to that described for the field test.

Results were analyzed using ANOVA (16). Paired comparisons were made using the least significant difference (LSD) procedure. Percentage data were transformed to arcsine before analysis.

Results

Field and growth chamber tests showed high infestation levels; none of the Nasma plants escaped infestation (Tables 1 and 3). The analysis of variance of the percent plants resistant showed a highly significant ($P<0.0001$) difference between the entries. In comparison to the cultivar saada (H5), the line ADC14 showed only a moderate level of resistance in both field (55.6%) and greenhouse (52%) tests (Tables 1 and 3). Resistant plants had dead first instars indicating that the mechanism responsible for the resistance of ADC14 is antibiosis. Saada had significantly ($P<0.01$) higher number of dead first instars than ADC14 (Table 2). However, ADC14 line had significantly ($P<0.05$) lower number of live larvae per plant than the susceptible check Nasma. Interestingly, this Algerian land race allowed for some larval survival on resistant plants. 18% of the resistant plants (Table 1) had an average of 1.3 live larvae per plant, whereas Saada was highly antibiotic and did not allow for any larval survival (Table 2).

Table 1. Reaction of the bread wheat line ADC14 for resistance to Hessian fly, in a growth chamber test, Settat, Morocco.

Plant Genotypes	No. of Plants tested	% plants resistant	% Resistant plants with live larvae
ADC14	63	52.0 b[1]	17.8 a
Saada (H5)	56	100.0 a	0.0 b
Nasma	48	0.0 c	--

[1] Means followed by the same letter are not significantly different (P=0.05; LSD test {SAS Institute 1985}.

Table 2. Antibiotic effect of wheat resistant plants on Hessian fly larvae, in a growth chamber test, Settat, Morocco.

Plant Genotypes	No. of live larvae/ resistant plant	No. of dead larvae/ resistant plant	No. of live larvae/ susceptible plant
ADC14	1.3 a[1]	1.5 a	2.7 a
Saada (H5)	0.0 b	3.5 b	--
Nasma	--	--	5.2 b

[1] Means followed by the same letter are not significantly different (P=0.05; LSD test {SAS Institute 1985}.

Table 3. Reaction of the bread wheat line ADC14 for resistance to Hessian fly, at Jemaa Shaim experiment station, Morocco.

Plant Genotypes	No. of plants tested	% plants resistant
ADC14	18	55.6
Saada (H5)	25	100.0
Nasma	16	0.0

Discussion

The bread wheat line ADC14 is the first source of resistance to Hessian fly in Morocco identified in a North African wheat collection. It will be interesting to know if this line confers resistance to the Algerian Hessian fly. This information should show if the Moroccan and Algerian biotypes are the same or different. In collaboration with wheat breeders, we are studying the inheritance of this resistance to identify how many genes are involved and whether or not they are different from those already identified. The only known source of resistance to Hessian fly from the Mediterranean region is the Portuguese cultivar 'Ribeiro' that carries H5 gene (14).

Eventhough this Algerian land race showed only a moderate level of resistance, it seems very interesting. The fact that 18% of the resistant plants had live larvae should dilute virulence in the Hessian fly populations. Since these larvae that survived on resistant plants were shown to be avirulent (6), the deployment of resistant varieties carrying this type of resistance should slow down biotype development. El Bouhssini *et al.* (6, 8) showed that the resistance genes H1H2, H18, and H7H8 allowed for larval survival on resistant plants.

Particular efforts should be put on the evaluation of wheat germplasm from North Africa and Southern Europe to locate sources of resistance to Hessian fly and to other pests.

Also, special attention should be given to sources of resistance that allow for avirulent larvae to survive on resistant plants or on tolerant lines. Varieties carrying this type of resistance should be less selective for biotype development.

الملخص

البوحسيني، مصطفى، السعدية الحلوي، نجاة نابر، محمد مركوم، عبد القادر بن بلقاسم وجيمي هاتشط. 1996. صنف جديد مقاوم لذبابة هس (Diptera: Cecidomyiidae) اكتشف ضمن قمح طري جزائري. مجلة وقاية النبات العربية: 14 (2): 102-104.

تلحق ذبابة هس (Say) *Mayetiola destructor*، خسائر جسيمة بالقمح الصلب والطري في المغرب. لذا فقد بذلت مجهودات كبيرة في المقاومة الوراثية لمكافحة هذه الحشرة. أجريت هذه التجربة التقويمية لسلالات جزائرية من القمح الطري الجزائري بالحقل وداخل البيوت الزجاجية بغية العثور على أنواع جديدة مقاومة لذبابة هس. أظهرت النتائج أن لسلالة ADC14 مقاومة متوسطة لهذه الحشرة. وهذه أول سلالة مقاومة تكتشف في قمح شمالي افريقيا. ويشير وجود يرقات الطور الأول ميتة إلى أن عامل المقاومة بسلالة ADC14 هو تضاد حيوي *antibiosis*. لكن 18% من النبات المقاوم كان يحتوي على يرقات حية. يجب تشجيع استعمال الأصناف التي تسمح لعيش اليرقات على النبات المقاوم، لأن ذلك سيخفف من تطور أنواع فتاكة للحشرة.

كلمات مفتاحية: ذبابة هس، قمح طري، المقاومة.

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