"Short Communication"

First sources of resistance to *Sitona* weevil (*Sitona crinitus* Herbst) in wild *Lens* species

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Abstract

Lentil is one of the important cool-season food legumes grown in many countries in the Mediterranean region. But a substantial yield loss is observed every year due to various biotic stresses. The *Sitona* weevil (*Sitona crinitus* Herbst) is a major insect pest limiting lentil productivity mainly in the countries of West Asia and North Africa region. The adult insects feed on the leaflets at seedling stage, and the plant suffers due to reduced photosynthesis. The larvae feed on the root systems and on the nodules, thus decreasing the ability of the plant to fix atmospheric nitrogen. Since sources of resistance to this pest in the cultivated lentil *Lens culinaris* Medikus subsp. *culinaris* are lacking, we searched for resistant sources in a collection of wild *Lens* species available in the ICARDA Gene Bank. We screened 315 accessions of wild lentil covering all known species/sub-species based on nodule damage at ICARDA's main experimental station (Tel Hadya, Aleppo), a hot-spot for the pest in the region. Large variation was observed in the percent nodule damage among accessions across species. Eight accessions, ILWL 110, ILWL 136, ILWL 166, ILWL 203, ILWL 207, ILWL 245, ILWL 254 and ILWL 258 were identified as resistant, with ≤10 % nodule damage, compared to >56% damage recorded on

the cultivated lentil. This is the first report of resistance against *Sitona* weevil in lentil. One resistant accession ILWL 245 belongs to the species *L. culinaris* Medikus subsp. *orientalis* (Boiss.) Ponert, progenitor of the cultivated lentil, which is crossable with the cultivated lentil. This line is being used to introgress resistance genes to cultivated lentil and to understand the inheritance of *Sitona* weevil resistance.

Introduction

The lentil leaf weevil, *Sitona crinitus* Herbst, is the main insect pest of lentil in West Asia and North Africa (Hariri, 1981; Solh et al., 1986). Among *Sitona* species infesting lentils in northern Syria, *S. crinitus* Herbst is the most abundant (Tahhan and Hariri, 1982a). It comprises > 95% of the *Sitona* species on lentil, and is found throughout Syria and the rest of West Asia and North Africa (ICARDA, 1993). Adult insect feeds on the edges of the leaflets causing severe damage to young seedlings. The most important damage, however, is caused by the larvae feeding on the nodules, which affects the ability of the plant to fix atmospheric nitrogen (Hariri, 1981; Weigand et al., 1991). Infestation of leaflets may be >90% and the larvae may destroy most of the nodules (Cardona, 1983; Tahhan and Hariri, 1982b) and the plants suffer from nitrogen deficiency at vegetative growth stage. At high infestation level (93.5% nodule damage), the insect caused 17.7 and 14.1% losses in straw and grain yields, respectively (ICARDA, 1983). However, it is anticipated that the reduction in nitrogen fixation may have a major effect on the N-status of the system as a whole and the subsequent cereal crop in particular.

Even though there are effective insecticides to control *Sitona* weevil (Weigand et al., 1991), farmers do not use them because of high cost and the unreliability of availability in the market. Moreover, use of insecticide is environmentally detrimental. ICARDA has the largest

collection of lentil accessions globally, of which 585 are wild relatives collected from 14 countries (GRU, 2006). Screening of a large number of cultivated lentils comprising landraces and breeding lines at ICARDA has shown that sources of resistance/partial resistance are lacking in cultivated species (Erskine and Sarker, 2004).

The objective of this study was, therefore, to search for sources of resistance to *Sitona* weevil in the following wild *Lens* species: *L. culinaris* Medikus subsp. *orientalis* (Boiss.) Ponert, *L. culinaris* Medikus subsp. *odemensis* Ladizinsky , *L. culinaris* Medikus subsp. *tomentosus* Ladizinsky , *L. lamoteii* Czefranova , *L. nigricans* (M.Bieb.) Godron and *L. ervoides* (Brign.) Grande.

Materials and methods

We screened 315 accessions of wild lentil for resistance to *Sitona* weevil in the field under natural infestation at Tel Hadya, the main experimental station of the International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. The accessions screened were randomly selected from the 585 accessions across four species of wild *Lens* (Table 1). The materials were collected from Syria, Turkey, Libya, Turkmenistan, Palestine, France, Bosnia, Croatia, Serbia, Lebanon, Armenia, Italy, Spain, Tajikistan, Uzbekistan, Jordan, Ukraine, Slovenia and Iran. The numbers of accessions of each wild species, along with their source of origin, are shown in Table 1. Because of the volume of work, the accessions were evaluated in initial screening over the period 2001 to 2005. Promising lines were re-evaluated in 2002 to 2006 cropping seasons. A Syrian local lentil cultivar (ILL 4401) was included as a susceptible check. In initial screening, each accession was sown unreplicated in a single row plot of one meter length with 45 cm spacing between rows. Those accessions which showed nodule damage of 10% or less in initial screening were re-evaluated in replicated trials under the same field

conditions the next season in single row 1 m long plot with 45 cm spacing in four replications using a randomized complete block design.

The evaluation for resistance was based on nodule damage. Nodule damage was assessed from samples taken at flowering time (mid-April). Five plants were randomly selected from each plot, uprooted with soil to recover most of the root system, which was then washed in the laboratory. Then the number of total and damaged nodules on each plant were counted and with damage expressed as a percentage of the total number of nodules. Statistical analysis of data on nodule damage was carried out following a generalized linear model based on binomial error and logit link function using GenStat Version 9.1 (Payne, 2000). Such a model fitting used chi-square statistics for testing significance of the genotypes and produced predicted values of nodule damage for the individual genotypes along with the estimated standard error.

Results and Discussion

Table 1 shows the number of accessions in each species, their origin, and the range and mean of nodule damage in initial evaluation during the 2001 to 2005 cropping seasons. The largest number of accessions screened were *L. culinaris* ssp. *orientalis* (134) followed by *L. ervoides* (74) and *L. culinaris* ssp. *odemensis* (57). Accessions of *L. culinaris* ssp. *orientalis* originated from 11 countries and showed a wide range of nodule damage (0-84%) with a mean damage of 45%. Resistance was found in all species and subspecies except *L. culinaris* ssp. *tomentosus* and *L. lamottei* by a reaction of 10% or less nodule damage in initial screening. This might be due to the small number of accessions (only six in *L. culinaris* ssp. *tomentosus* and nine in *L. lamottei*) that were evaluated in these two species. It is possible that a wider range in host response to weevil damage would have been observed with a larger sample size.

Table 1- here

In the re-evaluation screening, highly significant differences ($P \leq 0.001$) in the percent nodule damage were found among wild accessions including a Syrian local cultivar (cultivated lentil), tested over the years. A total of eight accessions which were resistant (<10% nodule damage) in initial screening, confirmed their resistance reaction (<10%) in advanced evaluation (Table 2).

Table 2- here

These accessions are: *L. culinaris* ssp. *orientalis* (ILWL 245), *L. culinaris* ssp. *odemensis* (ILWL 166, ILWL 203, ILWL 207 and ILWL 254), *L. ervoides* (ILWL 136, and ILWL 258) and *L. nigricans* (ILWL 110). They showed 10% or less nodule damage compared to 57% damage in the Syrian local cultivar. The resistant accessions originated from West Asia (Turkey and Syria), with the exception of accession ILWL 207, which originated from Croatia. This is the first report on resistance against *Sitona* weevil in lentil. Previous research on host plant resistance in the cultivated lentil against *S. crinitus* did not produce conclusive results (Tahhan and Hariri, 1983). Among the resistant wild lentil accessions, ILWL 245 is crossable with the cultigen. This is currently in use in crosses at ICARDA to introgress resistance genes in agronomically superior cultivars/genotypes and to study the inheritance of *Sitona* resistance.

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Table 1 . Reaction of wild species of lentil for resistance to *Sitona* weevil, evaluated in initial screening during 2001 to 2005 crop seasons.

Species	Number of accessions tested	Country of origin	Range of nodule damage	Mean
Lens culinaris ssp. *odemensis*	57	LBY* (1), PAL (2), SYR (36), TUR (18)	4 -71 %	33 %
Lens culinaris ssp. *orientalis*	134	ARM(1), IRN (3), JOR (5), LBN (1), SYR (80),TJK (4), TKM (2), TUR (32), UZB (6).	0-84 %	45 %
Lens culinaris ssp. *tomentosus*	6	SYR (1), TUR (5).	14-43 %	25 %
Lens ervoides	74	BIH (1), HRV(10), SVN (1), SYR (31), TUR (23), UKR (1), ITA (3), PAL (3), SCG (1)	3-67 %	30 %
Lens lamottei	9	ESP (6), FRA (1), TUR (2).	20-51 %	40 %
Lens nigricans	35	ESP (5), FRA (4), HRV(5), ITA (2), TUR (18), UKR (1).	5-67 %	27 %

* LBY= Libya, PAL= Palestine, SYR= Syria, TUR= Turkey, ARM= Armenia, IRN= Iran, JOR= Jordan, LBN= Lebanon, TJK= Tajikistan, TKM= Turkmenistan, UZB= Uzbekistan, BIH= Bosnia, HRV= Croatia, SVN= Slovenia, SCG= Serbia and Montenegro, UKR= Ukraine, ESP= Spain, FRA= France, ITA= Italy

Table 2. Wild accessions resistant to *Sitona* weevil observed in field screening at ICARDA during 2001-2006 crop season

Accession	Species	Country of origin	% Nodules damaged
ILWL 110	*L. nigricans*	Turkey	9.2 (8.0[1] ± 2.0[2])
ILWL 166	*L. culinaris* ssp. *odemensis*	Syria	9.6 (10.2 ± 2.3)
ILWL 136	*L. ervoides*	Syria	8.3 (6.3 ± 2.3)
ILWL 203	*L. culinaris* ssp. *odemensis*	Turkey	10.0 (10.4 ± 2.)
ILWL 207	*L. culinaris* ssp. *odemensis*	Croatia	9.6 (7.8 ± 2.3)
ILWL 245	*L. culinaris* ssp. *orientalis*	Syria	9.9 (8.9 ± 2.2)
ILWL 254	*L. culinaris* ssp. *odemensis*	Syria	10.0 (9.5 ± 2.1)
ILWL 258	*L. ervoides*	Turkey	9.2 (11.8 ± 2.7)
Susceptible cultivated check	ILL 4401 *Lens culinaris* ssp. *culinaris*	Syria	56 (57.0 ± 3.3)

[1] Predicted value of % nodule damage