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Screening of wheat genotypes for leaf rust resistance along with grain yield

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Abstract Leaf rust caused by *Puccinia triticina* Eriks., is one of the main diseases of wheat (*Triticum aestivum* L.) in Egypt, causing up to 50% of yield losses. Genetic resistance is the most economic and effective means of reducing yield losses caused by the disease. However, breeding genotypes for disease resistance is a continuous process and plant breeders need to add new effective sources to their breeding materials. Among 42 Egyptian wheat varieties screened for leaf rust resistance, only 9 varieties (Sakha94, Giza168, Gemmiza9, Gemmiza10, Gemmiza11, Sids12, Sids13, Misr1 and Misr2) exhibited seedling and adult plant resistance during 2010/11 and 2011/12 growing seasons. Out of 41 monogenic line (*Lr* genes) tested, only 13 *Lr* genes (*Lr9*, *Lr10*, *Lr11*, *Lr16*, *Lr18*, *Lr19*, *Lr26*, *Lr27*, *Lr29*, *Lr30*, *Lr34*, *Lr42* and *Lr46*) exhibited seedling resistance while, 9 *Lr* genes (*Lr*19, *Lr*20, *Lr*21, *Lr*24, *Lr*29, *Lr*30, *Lr*32, *Lr*34 and *Lr*44) showed adult plant resistance at both growing seasons. This result may add a depth of their resistance to be exploited as good sources of resistance. Partial resistance traits of wheat seedlings were present in 12 varieties (Sids12, Misr2, Sakha94, Misr1, Sids13, Giza168, Gemmiza9, Sids7, Beniswef4, Sakha93, Gemmiza11 and Sids6), recording the longest incubation and latent period. However, 10 varieties (Sakha8, Sakha93, Giza144, Giza155, Giza156, Giza157, Sids4, Sids5, Sids8 and Beniswef4) were marked as having high level of partial resistance of adult plant, recording ACI less than 20%, AUDPC less than 332.5 and *r*-value less than 0.101. The highest significant loss percentages were found in susceptible wheat cultivars *i.e.* Gemmiza7, Sakha61 and Giza164 (12.24%, 12.10% and 9.08%, respectively). However, insignificant loss percentages were found in resistant cultivars *i.e.* Giza168 (1.87%), Misr2 (2.44%) Sakha94 (2.46%). Inverse relation was present between the disease level and grain yield.

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Cultivating of resistant cultivars such as Misr2, Giza168 and Sakha94 is recommended to escape heavy yield losses wreaked by the leaf rust disease.

Introduction

Wheat (*Triticum aestivum* L.) is a host for three rust diseases, stripe, leaf and stem rust. Leaf rust disease is considered the most common and widely distributed of the three wheat rusts and has become more serious problem of wheat causing great losses in grain yield (Huerta-Espino et al., 2011). The significance of disease, in particular, depends upon the prevalence of aggressive and/or virulent races of the pathogen as well as their affinity or compatibility with the genetic constitutions of the host in a given environment. Therefore, the cultivated Egyptian wheat varieties have suffered from sudden epidemics during the last decades from the perspective of change in weather conditions in relation to the genetic makeup of both host and parasite (El-Daoudi et al., 1987). The leaf rust epidemic in Egypt was recorded during 1945 and 1968 (Abdel-Hak and Kamel, 1972).

Leaf rust of wheat is caused by the fungus *Puccinia triticina* Eriks. (syn. *P. recondita* Rob. Ex Desm. f. sp. *tritici* Eriks. and Henn.) which attacks the leaf blades, although it can also infect the leaf sheath and glumes in highly susceptible cultivars (Huerta-Espino et al., 2011). Leaf rust disease decreased numbers of kernels per head and lower kernel weights (Roelfs et al., 1992; Marasas et al.,2004; Kolmer et al., 2005). Early infection of leaf rust on wheat generally causes higher yield losses; 60–70% infection on the flag leaf at spike emergence may account for a yield loss of more than 30%. Bajwa et al. (1986) reported that losses in kernel weight of wheat varieties due to leaf rust infection ranged between 2.0% and 41% according to the level of resistance or susceptibility.

Egypt is located in the epidemiological zone of leaf rust (Saari and Prescott, 1985) where yield losses of wheat could reach 50% (Abdel-Hak et al., 1980). Such disease eliminated many wheat cultivars such as Giza139, Chenab70, SuperX, Giza158 and Giza160 (Nazim et al., 1983). Plant breeding for disease resistance is one of the most important methods for diminishing the yield loss of wheat.

Resistance expression depends on the host–parasite interaction, environmental conditions, plant growth stage and the interaction between resistance genes in wheat genome (Kolmer, 1996). Most of 60 leaf rust resistance genes confer race-specific resistance in a gene-for-gene manner (McIntosh et al., 2007). However, wheat varieties relying on race-specific resistance often lose effectiveness within a few years by imposing selection for virulent leaf rust races. In addition, the cultivation of a large area of susceptible wheat cultivars allows a large leaf rust population to proliferate, creating a reservoir for mutation and selection (Kolmer et al., 2005).

New sources of resistance could be incorporated into wheat to diverse the existing gene pool for leaf rust resistance (Singh et al., 1998). The genes found effective against leaf rust may be deployed singly or in combination with high yielding genes to develop high-yielding resistant wheat cultivars in wheat-growing areas in where leaf rust races have the same virulence profile to the prevalent race/s. Genetic resistance is the most economic and effective means of reducing yield losses caused by leaf rust disease (Liu and Kolmer, 1997b). Singh et al. (1991) reported that loss in grain yield due to leaf rust of wheat could be reduced in levels similar to those of hypersensitive resistant genotypes by the use of partial resistance which give long-lasting resistance at a negligible costing yield that is in sufficient to justify the use of fungicide. Also, Herrera-Foessel et al. (2006) found that mean yield losses for susceptible, race-specific, and slow-rusting genotypes were 51%, 5%, and 26%, respectively, in the normal sowing date trial and 71%, 11%, and 44% when sown late.

The present work aimed to screen wheat genotypes for leaf rust resistance at seedling and adult plant stages along with grain yield, seeking for new sources of resistance to escape heavy yield losses wreaked by the leaf rust disease.

Material and methods

Different wheat genotypes including 42 Egyptian varieties (Table 1) and 41 monogenic lines (Table 2) were screened for leaf rust resistance at both seedling and adult plant stages during two successive growing seasons, 2010/11 and 2011/12. Seeds of all wheat genotypes were obtained from Wheat Disease Research Department, Plant Pathology Research Institute, Agricultural Research Centre, Egypt.

Seedling resistance investigation

Seedling response to leaf rust was investigated at the Greenhouse of Wheat Disease Research Department, Sakha Agricultural Research Station, Agric. Res. Centre during 2010/11 and 2011/12 growing seasons. The experiment was carried out in a completely randomized design with three replicates. Grains of the tested wheat varieties and lines (Tables 1 and 2) were sown in plastic pots (10 cm. diam.). Each pot received 10 kernels in a clay soil. Eight-days-old seedlings were inoculated with virulent race of *P. triticina* (TTTTT) using urediniospores as described by Stakman et al. (1962). The inoculated plants were incubated in a dark dew chamber overnight at 18 °C, then moved to the benches in the greenhouse and maintained at 19–22 °C and 95–100% relative humidity. Light intensity was supplied at about 7600 lux in a photoperiod of 16 h light and 8 h dark (Ohm and Shaner, 1976). Seedings were kept under observation until the development of rust pustules.

Seedling response was scored two weeks after inoculation based on the infection types expressed on each entry. The infection types 0, 0;, 1, 2, 3, 4, and X (Table 3) as described by Johnston and Browder (1966) were used for disease assessment. Plants with the infection types 0, 0;, 1 and 2 were considered resistant response (R), while infection types 3, 4 and X were considered susceptible ones (S).