International Research Journal of Biotechnology Vol. 14(1) pp. 1-3, February, 2023
Available online http://www.interesjournals.org/IRJOB

Mini Review

The Genetic Content of Wheat Ensures a Natural Grain

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Received: 2-Feb-2022, Manuscript No. irjob-23-87358; **Editor assigned:** 06-Feb-2022, PreQC No. irjob-23-87358 (PQ); **Reviewed:** 20-Feb-2022, QC No. irjob-23-87358; **Revised:** 22-Feb-2022, Manuscript No. irjob-23-87358 (R); **Published:** 28-Feb-2023, DOI: 10.14303/2141-5153.2023.32

Abstract

The disease is mainly caused by her two types of pathogens. Zymoseptoria tritici, which damages leaves, and Parastagonospora nodorum, which affects leaves and panicles. Resistance genes from extraterrestrial relatives have traditionally been used to genetically protect strains. The aim of this study was to determine the resistance of his Thinopyrum ponticum (Podp.) I review a summer wheat introgression line containing genetic material on a Septoria blotch and characterize agronomic traits for use in breeding programs in western Siberia. The study was conducted from 2015 to 2019 in field conditions in the southern forest steppe (Omsk, Russia) using standard methods against the background of natural infection. Septoria disease occurred in wheat during the ripening period of milk wax regardless of wet or dry weather conditions. A sharp increase in leaf lesions was seen in his 2016, which may be related to changes in his Z. tritici population. In 2017, the ratios of Z. tritici and P. nodorum were similar, and in 2019 Z. tritici dominated. During the study, lines were selected that were resistant to leaf and panicle damage and had high yield and grain quality.

Keywords: Septoria blotch, Zymoseptoria tritici, Parastagonospora nodorum, Disease resistance, Grain quality

INTRODUCTION

The most important cereal species for feeding the world population. Its crops worldwide he occupies more than 200 million hectares. Due to projected population growth, wheat production will need to increase by about 70 times by 2050 **(Alkhatib G 2009).** Two directions have been proposed to address this issue. The first is to increase the potential productivity of the variety and the second is to reduce crop losses due to abiotic and biotic factors. Recently, Septoria lesions have become he one of the most economically important wheat diseases in the world **(Wilen CB et al., 2012)**. Septoria disease of wheat is caused by sac fungi hemobiotrophs that are mainly damaged by Dosideomycetes on leaves and panicles. Z. tritici wreaks havoc on wheat in Europe, North America and Australia. In the 1970s and 1980s epidemics with 50% crop losses were recorded in wet coastal areas. Due to disease progression in the 2010s, annual crop protection costs exceeded €400 million in the EU (70% of total fungicide costs) and $275 million in the US **(Mainou BA et al., 2015)**. The rapid development and progressive crop damage of Z. tritici are caused by the biological characteristics of the species. Pathogen variability is determined by high-level mutational processes and accumulation of altered genes (up to 1011 spores/ha under favorable conditions) during reproductive development, leading to the emergence of new phenotypes (up to 20,000 spores/ha) in abundance **(Xu GG 2014)**.Population heterogeneity is amplified by chromosomal rearrangements and gene combinations associated with regular sexual processes. The pathogen has a mixed reproductive system. The sexual process takes place in the pseudocyst, forming ascospores and spreading through the air. After inoculating the plant with ascospores, the asexual stage begins and conidia with conidia develop. Airborne migration of ascospores enables rapid migration of new morphologies, and selection and fixation of the best phenotype within the population occurs at the asexual stage **(Woollard SM et al., 2015)**. Similar genetic underpinnings of cultivars, environmental conditions, and use of comparably effective fungicides may be a factor driving the microevolution of Experience with wheat production in the EU has shown that

Z. tritici can rapidly overcome cultivar defenses and acquire fungicide resistance. Biological properties of P. nodorum have been poorly studied, but are likely to adapt to local conditions. Directional selection for fungicide resistance and presence at elevated temperatures has been noted in fungal populations. Acceleration of pathogen adaptation to environmental conditions is facilitated through the use of intensive crop production techniques such as: B. No-tillage when large numbers of propagules with new phenotypes remain in the stubble **(Kumar A et al., 2017)**.

Isolated cases of Septoria spot have been identified, and the disease is now widespread in most wheat-growing regions. Three causative agents of Septoria disease have been identified in Russian crops. However, there was an uneven distribution of species. Z. tritici was predominant in the southern regions (North Caucasus, Central Black and Volga regions). Dividing Z equally tritici and P **(Hamel R et al., 2015)**. nodorum are found in the central zone of European Russia. P. nodorum was dominant in the northern and eastern regions. frequency of P Avenae f. sp. pathogen complex triticale was low in these areas. In the central black soil region, septoria spots occurred annually from 2008 to 2017, reaching average yield losses for spring and winter wheat cultivars. At the same time, sowing characteristics and grain quality are reduced. Given the biological characteristics of Z. tritici and P. nodorum, increased damage from Septoria is predicted, increasing the risk of global food insecurity. Validity evaluation of the Stb1-Stb8 genes in the European part of Russia showed that only two of them (Stb6 and Stb8) were resistant to all populations of Z. tritici and three (Stb2, Stb3 and Stb4) were shown to exhibit resistance to individual regional subpopulations, and the remaining genes were already overcome by the pathogen breeding is very limited. In this regard, it is necessary to look for sources of resistance and promote wheat breeding, taking into account the regional distribution of pathogen species. Traditionally, non-native relatives, particularly the genus Thinopyrum, have been used to enrich the wheat gene pool **(Li E et al., 1998)**. The first research on long-distance hybridization between wheat and cinopyrum (Agropylon) species was carried out in the 1920s by the Russian scholar N. V. Tsitsyn and his colleagues. The most promising species was the tall wheatgrass Thinopyrum ponticum. A wheat-wheatgrass hybrid (WWH) was created and used to introduce foreign genetic material into the wheat genome a perennial regrowth WWH and hardy wheat variety **(Danthi P 2010)**.

METHODS

Experiments were conducted from 2015 to 2019 in field conditions against a background of natural infection with Septoria haemophilus in the southern forest steppe of West Siberia (Omsk, 54.58_N, 73.24_E). The Th. ponticum strain was reported in 2010 and is preserved thanks to its perennial lifestyle. Other samples were sown at the onset of optimal conditions in the third decade of May. In 2015-2016, samples were sown in rows at a seeding density of 40 seeds/m 4 . From 2017 to 2019, wheat samples were tested in plot tests (three 1 m2 plots at a sowing density of 500 seeds/m2). Phenomenology was determined on the Zadox scale. Harvest took place in his third decade of August when the plants mature. Yield characteristics and grain yield (g) and 1000-grain weight (g) per plant were determined for bundle materials (except perennial Th. ponticum). Septoria spot severity was assessed separately in lobes and ears (%) according to the James scale. As the symptoms of the disease appeared between his 10 and 30 years of age, the first of August, estimates were made in dynamics, with a final assessment at the onset of waxy maturity (Zadoks, Ph. . 82). Samples were divided into groups according to disease severity. persistent -6–20%; weakly susceptible -21–40%; vulnerable -41–65%; highly susceptible -66–100%. Identification of his Z. tritici and P. nodorum infections in wheat was carried out on specimen material (40 leaves/ sample) collected from 2017 to 2019 at the trial plot of SAU Omsk. A small piece of dried leaf containing fruiting bodies (0.5 x 0.5 cm) was placed in a drop of water on a glass slide for 15 min. After release of conidiospores, fungal species were determined based on their shape and size. The frequency of occurrence of species on the samples was determined as the percentage of Z. tritici or P. nodorum sporulation in the total number (%) analyzed.

Environmental Conditions

Weather conditions between July (before disease onset) and August (during disease onset) varied significantly between 2015 and 2019. Moderate rainfall was observed in 2015 and 2018 with moderate 10-day mean temperatures (13-17 °C) during the third decade of July and August. July 2016 and 2017 saw ample rainfall (103mm and 71mm respectively), but severe drought in August (17mm and 13mm respectively) and 18mm Temperatures as high as ~20 °C occurred. July and August 2019 were dry, warm and mild **(Campbell ID 2011)**. Hydrothermal Coefficient According to HTC, the weather conditions in August 2015 and August 2018 were characterized as excessively humid (4.17 and 3.37 respectively). 2016 and 2017 are poor (HTC = 0.63 and 0.57 respectively). And 2019 will be a satisfying one.

RESULTS

The first symptoms of septoria spots on wheat leaves appeared in early August during milk ripening (Zadoks, pp.71–75), followed by ear damage 7–10 days later. The greatest severity of disease was seen in the 30th year of August when waxes mature (Zadoks, pp.81-85). From 2015 to 2019, all Th. ponticum accessions (including parental accessions) showed no visible disease symptoms (0% severity, immune). 2013-2014 standard medium mature cv. duet and mid-late CV. Serebristaya was resistant or weakly susceptible (severity 10-25%) to his Septoria leaf spot and about half of the introgression lines were resistant to the disease. Under humid conditions in August 2015, mid-early cv. whereas other standard and parental cultivars were resistant or less susceptible (severity 5-25%). Among the set of introgression lines, 30% were resistant, 15% were moderately susceptible, others were susceptible, and highly susceptible. However, in very dry conditions in August 2016, the final evaluation showed a sharp increase in leaf damage. The disease may have been caused to some extent by heavy rains during the thirtieth year of July followed by periodic dew. All breeds and 95% of strains showed high susceptibility (75% severity). At the same time, we found a slight negative effect of leaf lesions on grain yield ($r = -0.11$). This can be explained by the delayed onset of the disease.

Discussion

It was previously shown that Septoria spot development in European, North American and Australian wheat is highly dependent on rainfall and rainfall duration, thus coastal crops are most affected. In summer, disease progression was mainly associated with infection by asexual conidiospores (6–12 generations per season). It has been shown that liquid dripping water is required to release the asexual spores of Pycnids. Therefore, at least 10 mm of rainfall, 1 mm of 3 consecutive days of rainfall, moderate temperature, high humidity (98%), or regular dew were required to induce infection in wheat. Sprinkling the seedlings in the canopy with raindrops promotes seedling reproduction. Wheat samples from the Moscow and Kirov regions showed that in wet weather, leaf damage can occur during the elongation period of tiller stems, leading to plant death. Spore release from the conidia did not occur in the absence of liquid water and low humidity, leading to disease suppression. Our study was conducted in the forest-steppe zone of southwestern Siberia, a region characterized by a strong continental climate. During the growing season, plants are exposed to stresses such as large temperature changes and drought. In recent years, long periods of no precipitation have been observed every three seasons, but he is most typical for the region in spring and early summer drought from April to June. Due to the climatic characteristics of the neighboring regions of Western Siberia and Kazakhstan, mainly soft wheat is grown, forming a 'wheat belt' spanning millions of hectares. Wheat cultivars and climate-adapted Asian parasitic fungal populations are present in these crops.

CONCLUSIONS

Phylogenetic lines of summer wheat introgression lines containing Th. ponticum and its genetic material were tested for resistance to Septoria blotch in the southern forest steppes of Western Siberia (Omsk, Russia). Th. ponticum showed immunity to this disease in 2015-2019. In 2016, there was a significant increase in wheat leaf lesions without a significant increase in panicle damage. Increased leaf damage by Septoria spotting may have been related to changes in Z. tritici populations. Quantitative differences were found in the pathogen ratios of the introgression lines. This may be due to the different distribution of resistance genes. Introgression lines were selected that were resistant to leaf and spike damage. The best lines containing Th. ponticum genetic material, combining septoria blotch resistance with high yield and grain quality, provide valuable material for general wheat breeding.

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