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Research Article

Sanitary update on wheat in Argentina

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More Information

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The wheat production (*Triticum aestivum* L.) in Argentina is the third in importance after soybeans and corn (source: BCR). The production area in 2021-22 was 6.9 million hectares, the highest in the last 20 years. Total production was 20.4 million tons, with a national average yield of 3.1 tons/he (source: GEA-BCR). This achievement in production was due to good climatic conditions for crop growth, optimal fertilization management and also low diseases pressure, something unusual since in most years the diseases cause significant damage to production (source: INASE, BCR). The diseases in wheat in the world are responsible for 15% – 20% of yield losses per year [1]. In Argentina, the most important diseases are those that cause damage to the foliar tissues and spike [2], being the fungal diseases the ones that have the greatest impact compared to those caused by bacteria and viruses. The `rusts´ - Leaf rust (*Puccinia triticina* Erikss), Stem rust (*Puccinia graminis f. sp. tritici*) y Stripe rust (*Puccinia striiformis f. sp. Tritici.* Westend) - are the most important diseases, caused by pathogenic biotrophic fungi (basidiomycetes), due to its occurrence, distribution and economic importance. Powdery mildew, a disease also caused by a biotrophic pathogen (anomorphic *Blumeria graminis* f. *sp tritici*. [Speer), does not currently represent a threat to wheat production in Argentina because its annual presence is very low, affecting few varieties during the early crop growth stages [2]. Other diseases with minor impacts on production, according to agronomic management and production areas, are those that are part ´complex of leaf spots´ caused by necrotophic pathogenic fungi (ascomycetes): Tan spot (anomorphic *Drechslera tritici repentis* Drechsler), Spot blotch (anomorphic *Bipolaris sorokiniana.* Shoemaker), Alternaria leaf spot (*Alternaria spp*.) and Septoria (pycnidia-producing fungi) - Septoria leaf blotch (anomorphic *Zymoseptoria tritici* (Desm). Quaedvlieg & Crous) and Stagonospora Glume Blotch (anomorphic *Parastagonospora nodorum.* (Berk.) Quaedvlieg, Verkley & Crous) [3]. The most common bacterial diseases are Bacterial leaf blight (*Pseudomonas syringae* pv. *syringae*), Basal glume rot (*Pseudomonas syringae* pv. *atrofasciens*) and Bacterial leaf streak and black chaff (*Xanthomonas translucens* pv. *undulosa*) [2,4] and within the viral, the most important are Barley yellow dwarf virus (BYDV), Wheat streak mosaic virus (WSMV), High Plains Virus (HPV) and Barley Yellow Striate Mosaic Virus (BYSMV) [5.6].

Leaf rust was the most widespread and frequent in Argentina until 2016. Its effects on yield are usually moderate or severe, and can cause losses close to 50% [7] with average annual losses of 5% to 10% [8]. As in other parts of the world, genetic resistance is the most effective tool in its management [4,8,9]]. The current resistance base of wheat cultivars in Argentina, is given by major genes, specific race seedling resistance, which are effective from seedling but vulnerable to the emergence of new virulent races of the pathogen [10,11]. Genes effective against the disease were identified and used in local germplasm (*Lr 26, Lr 17, Lr16, Lr21, Lr 25, Lr 29, Lr 36, Lr 44 and Lr 47*) [10] (*Lr19 and Lr34*) [9]. This situation has been modified on the occasion of the presence of new physiological races in the pathogen or due to an increase in the frequency of some of them, derived from the sowing of susceptible varieties in a vast area with a specific combination of resistance genes [10, source: IICA]. Stem rust reemerged in 2014 and 2015 with severe attacks, after years where the disease had only been observed sporadically [12]. In variety trials (some of them widely spread) 50% were susceptible with an average yield reduction of 13% to 21%. Resistance genes (*Sr31, Sr24, Sr25, Sr8a, Sr11, Sr9b and Sr38*) were detected in those varieties, confirmed again in 2019 [13]. An important change occurred in the sanitary status of the wheat crop in Argentina from 2015 onwards, due to the presence of stripe rust in regions where it was not commonly observed. Until that year, it was only found in low incidence in the SE region of the province of Buenos Aires (38º 30'S and 60º 00'W) and occasionally in

2010 in the province of Entre Ríos (32º 54'S and 59º 10' W) [14]. Everything changed from 2016 when it was necessary to carry out chemical controls of the disease. In 2017, the largest epidemic of this disease occurred after 70 years, affecting more than 3 million hectares of wheat [14,15]. This implied racial changes in the pathogen with adaptation to environments with higher temperatures [16]. From samples sent to Denmark (Aarhus University) and later to the UK (John Innes Centre), it was also confirmed the presence of low virulence races, races called "Warrior" present in Europe, characterized by their aggressiveness overcoming the resistance provided by the resistance genes present in European germplasm [14]. Currently, crop improvement programs are searching for effective genes and introducing them into adapted germplasm. The combination of 4 to 5 genes with an additive effect or non-specific race is effective in reducing the progress of the disease to low levels, where only minimum percentages of severity can be observed (from 5 to 10% of infection in the flag leaf) [17]. In Argentina, effective genes were identified for all the identified breeds (*Yr5a, Yr10, Yr15* and *Yr24/26*) with the possibility of using them in breeding programs [18]. In mapping work on QTLs for resistance to yellow rust, where a population derived from Klein Proteo/Klein Chajá (partially resistant Argentine varieties) was used, 4 QTLs with additive effects were identified, which combined provide effective resistance [16]. Both diseases were the cause of yield losses greater than 50% [15,19,20]. Facultative pathogens (necrotrophs) see their survival made possible in remains of previous crops. Currently, Argentina is the main country that applies direct sowing technology (conservation tillage system) in 90% of the area destined for agriculture (source: AAPRESID). This reason is sufficient cause for the continuous presence of diseases in the different crops, originating from this group of fungi and also from bacterial agents [2,17,21,22]. In wheat, the most widespread disease today is Tan spot [2,21]. Yield losses measured in Argentina, ranged from 20 to 50% in chemical control trials [23]. As there are no varieties with genetic resistance and the high variability of the pathogen [2], its management is oriented towards efficient seed treatment (transmission), crop rotation and the choice of genotypes with the best performance [21,23]. In chemical control, losses in efficacy were noted and finally verified in some active ingredients belonging to the chemical group of strobilurins (IQe, external quinone inhibitors) as a consequence of a mutation (G143A) detected in the mitochondrial cytochrome b gene (cytb) in isolateds from the fungus [22]. Septoria Leaf spot (*Zymoseptoria tritici*) has been relevant in wheat with yield losses in Argentina of up to 50%, although currently its area of spread and occurrence is limited to the S-SW- of the province of Buenos Aires [2,8,24]. Septoria nodorum blotch (*Parastagonospora nodorum*) re-emerged in recent seasons, in uncommon areas of Argentina (province of Buenos Aires) after 80 years, due to the susceptibility of cultivars, lack of rotations direct sowing and use of inappropriate fungicides, associated to years wet [25].

The management of both diseases is dificult due to loss of genetic resistance and chemical control few effective (proven evidence in Europe of loss of sensitivity to triazoles, strobilurins and also carboxamides) [2].

Spot blotch (*Bipolaris sorokiniana*) occurs in temperate/warm and humid environments, but in Argentina it has spread to temperate zones where barley is grown (pathogen common to both species) [2,22]. Alternaria Leaf blight comprises several saprotrophic and pathogenic species widely distributed in various crops of agronomic importance. *A.alternata, A.tenuissima, A.infectoria* and *A.arborescens* were associated with wheat pathologies in Argentina [26] where it is also considered an emerging disease with a potential risk of becoming important [2]. FHB (*Fusarium graminearum*) is a disease with sporadic characteristics in Argentina, being the NE quadrant of the pampas region the one that can be most affected, due to greater climatic potentiality for the disease [27]. The last epidemics of this disease were in 2001-2002 and 2012 [28,29]. In severe attacks, yield losses of up to 60% occurred in Argentina. Under experimental conditions, the genetic behavior of varieties and new germplasm is characterized annually. In 2020, 36% of local varieties evaluated presented moderate resistance (severity <25%) to the disease [30] An achievement of the INTA breeding program was the creation of the MS INTA 416 variety released in 2016, which is a carrier of introgressed genes *Fhb1* (resistance to FHB) and *Lr47* (resistance to leaf rust) [31]. Under the production conditions of Argentina, the wheat crop is usually affected every year by Bacterial leaf blight (*Pseudomonas syringae*), favored by low temperatures and high relative humidity and some years and in specific cases by Bacterial leaf streak (*Xanthomonas translucens*) that depends on higher temperatures and humidity [32]. The impact that both diseases have on production is still unknown in Argentina, but this may be more important in irrigation production systems [2; source: SINAVIMO]. Finally, the wheat crop in Argentina can be affected by diseases caused by viruses. During 2021, in most of the wheat area, the presence of Wheat streak mosaic virus was confirmed by the DAS-ELISA serological technique from samples sent from experimental and production fields [5,33]. Most of the varieties were affected by this disease to different degrees with a predominance of mild to moderate symptoms [5,34,35]. Wheat health management in Argentina is based on all the possibilities available to minimize the disease problem. Genetic resistance is a priority in the management of rusts, complemented with chemical control. In the absence of effective genetic resistance, the management of necrotrophic fungi, bacterial and viral agents, is oriented towards an integral management where crop rotation, optimal crop nutrition and choice of varieties with better behavior take preponderance.

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