**Annexe 13.** Available knowledge in the scientific literature describing the effects of Cropping Practices and the Production Situation on the severity of brown Rust on Wheat. Cropping practices and weather can be favourable (+), unfavourable (-) or neutral (0) to the development of brown Rust. The intensity of the considered factor is summarised with 4 classes: 0, no effect; +, slight; ++, significant; +++, crucial.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factor** | **Direction of the effect** | **Intensity of the effect** | **Impact on brown rust development** | **References** |
| Tillage | 0 | 0 | No conclusion on the precise effect of soil tillage. Nevertheless, tillage seemed to be unfavourable for rotations with continuous wheat because volunteers’wheat emergence is greater than with no-till system. | (Ogg and Parker, 1989; Roelfs et al., 1992; Derksen et al., 1993; Pickett, 1993; Anderson and Soper, 2003; Plaskowska et al., 2009) |
| Volunteers wheat destruction | + | + | Presence of wheat volunteers, as reservoirs of inoculum for the autumn-planted winter wheat, favours the conservation of the disease during summer. The destruction of all volunteers’ wheat would significantly reduce the survival of primary inoculum. | (Roelfs et al., 1992; Derksen et al., 1993; Pickett, 1993; Eversmeyer and Kramer, 2000; Blackshaw et al., 2001; Anderson and Soper, 2003; Bolton et al., 2008) |
| Preceding and pre-preceding crop | 0 | 0 | The effect of rotation is very poorly described and its impact is presumably very less important (no conservation on residues). | (Anderson and Soper, 2003) |
| Sowing date | + | ++ | Brown rust has often been reported to be more severe in early sown crops. | (Mishra et al., 1994; Moschini and Perez, 1999; Eversmeyer and Kramer, 2000; Bancal M.O., 2010) |
| N fertilisation rate | + | ++ | N favours BR in increasing foliar area and in creating a dense canopy and a wet microclimate.  When nitrogen available in the host is limiting, spore production is reduced. Nitrogen deficiency tends to retard the epidemic development of most foliar diseases like powdery mildew, brown and yellow rusts. | (Mascagni et al., 1997; de Vallavieille-Pope et al., 2000; Robert et al., 2002; Robert et al., 2004) |
| Sowing rate | + | +/- | Contradictory results. For some authors, seeding density rarely had a significant influence on rust severity. Others suggested that microclimatic changes resulting from higher plant densities have lead to improved conditions for disease development. | (Chester, 1946; Pfleeger and Mundt, 1998) |
| Cultivar choice | + | +++ | Genetic resistance is the most economical method of reducing yield losses due to leaf rust. To date, 46 leaf rust resistance genes have been designated and mapped in wheat. But, new races of BR have been introduced in different continents and reduce the number of effective rust-resistance genes available for use. | (Kolmer, 1996; Eversmeyer and Kramer, 2000; Kolmer, 2005; Ordonez and Kolmer, 2007; German et al., 2009; Goyeau et al., 2009; Goyeau and Lannou, 2011; Goyeau et al., 2012; Azzimonti, 2013) |
| Cultivar mixture | + | + | The severity of leaf rust was lower in mixtures relative to monocultures. | (Mahmood et al., 1991; Vilichmeller, 1992; Lannou et al., 1994a; Lannou et al., 1994b; Jackson and Wennig, 1997; Pfleeger and Mundt, 1998; Mille and Vallavieille-Pope, 2001; Cox et al., 2004) |
| Climate | + | ++ | Urediniospores infect the telial host with free water on the leaf surface and temperatures of (5) or 10 (depends authors) –25 °C. Germination occurs after 4–8 h at 20 ºC under 100% humidity. The uredinial stage was thought to be unable to survive the hot, dry summers as susceptible host plants were not available. | (Samborski, 1985; Roelfs, 1989; Vallavieille-Pope et al., 1995; Eversmeyer and Kramer, 2000; Sache et al., 2000; Bolton et al., 2008)  (Roelfs et al., 1992)  (de Vallavieille-Pope et al., 2000) |
| Interactions with the territory | + | +/- | The rusts of wheat are fungal plant pathogens that can be disseminated thousands of kilometres across continents and oceans by wind.  The landscape varietal composition influences the resistance level of the most grown wheat varieties by altering the structure of the pathogen populations. | (Kolmer, 1996; Sache et al., 2000; Bolton et al., 2008; Papaix et al., 2011) |