Environ Sci Pollut Res
DOI 10.1007/s11356-014-2557-9

Brown rust disease control in winter wheat: II. Exploring the optimization of fungicide sprays through a decision support system

Moussa El Jarroudi · Louis Kouadio · Fréderic Giraud · Philippe Delfosse · Bernard Tychon

Received: 29 August 2013 / Accepted: 13 January 2014

Abstract A decision support system (DSS) involving an approach for predicting wheat leaf rust (WLR) infection and progress based on night weather variables (i.e., air temperature, relative humidity, and rainfall) and a mechanistic model for leaf emergence and development simulation (i.e., PROCULTURE) was tested in order to schedule fungicide time spray for controlling leaf rust progress in wheat fields. Experiments including a single fungicide treatment based upon the DSS along with double and triple treatment were carried out over the 2007–2009 cropping seasons in four representative Luxembourgish wheat field locations. The study showed that the WLR occurrences and severities differed according to the site, cultivar, and year. We also found out that the single fungicide treatment based on the DSS allowed a good protection of the three upper leaves of susceptible cultivars in fields with predominant WLR occurrences. The harvested grain yield was not significantly different from that of the double and triple fungicide-treated plots ($P<0.05$). Such results could serve as basis or be coupled to cost-effective and environmentally friendly crop management systems in operational context.

Keywords Fungicide treatment · Night weather · Leaf rust · Decision support system

Responsible editor: Philippe Garrigues

M. El Jarroudi (✉) · L. Kouadio · B. Tychon
Department of Environmental Sciences and Management, University of Liege, Arlon Campus Environnement, 185 Avenue de Longwy, Arlon 6700, Belgium
e-mail: meljarroudi@ulg.ac.be

F. Giraud
Laboratoire BIORIZON (STAPHYT Groupe), Rue Magendie/Site Bordeaux Montesquieu, 33650 Martillac, France

P. Delfosse
Environment and Agro-biotechnologies Department, Centre de Recherches Public Gabriel Lippmann, 41 Rue du Brill, Belvaux 4422, Luxembourg

Present Address:
L. Kouadio
Agriculture and Agri-Food Canada Lethbridge Research Centre, 5403 - 1st Avenue South, Lethbridge, AB T1J 4B1, Canada

Introduction

Wheat represents by far the major grain crop grown in the Grand Duchy of Luxembourg (GDL). In 2012, the area under wheat was 13,166 ha, with a total production of ca. 77,626 t (approximately 51 % of total cereal production) (Ministere de l'agriculture 2013). Several fungal diseases, including wheat leaf rust (WLR), affect the final yield throughout the growing season (El Jarroudi et al. 2009b). Losses from WLR infections are usually less damaging than those from stem rust and stripe rust (Eversmeyer and Kramer 2000); the important annual losses are associated with its more frequent and widespread occurrence. Yield losses in susceptible cultivar can reach 14 to 29 % in Europe (Hartleb et al. 1995) and are mostly due to reductions in kernel weight (Huerta-Espino et al. 2010). Reports in the Americas mention yield losses due to rust of 5–15 % in Canada, 10–22 % in the USA, up to 40 % in Mexico, and 9–51 % in Argentina (Moschini and Pérez 1999).

In the GDL, fungal management strategies in winter wheat are mostly based on the control of *Septoria tritici* (El Jarroudi et al. 2009a). However, WLR incidences have been observed to increase in severity over several growing seasons within the past decade (El Jarroudi et al. 2009b; El Jarroudi et al. 2012b). With the accelerated damages currently being infringed on the environment, it has become mandatory to gather all possible knowledge to support cost-effective and environmentally friendly crop management systems. Chemical control of WLR has been neither effective nor economical because the

Published online: 26 January 2014