Research Application Summary

Management of mycotoxins in wheat: Assessment of the role of plant residues, cropping systems and diversity of fungal species on mycotoxin contamination of wheat

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Abstract

The proposed project aims at assessing the role of crop residues, cropping systems and diversity of fungal species on mycotoxin contamination of wheat. Jointly done with wheat farmers, the project aims at recommending appropriate cropping systems to small-holder farmers and ultimately reduce *Fusarium* inoculum levels, increase wheat yield and improve human and livestock health by reducing exposure to mycotoxins. Two M.Sc. students will directly implement the proposed activities, acquiring skills in mycotoxin analysis and identification of the morphologically complex *Fusarium* species. The project will publish a brochure that can be used by wheat farmers and extension personnel while communication to the scientific community will be through publications in peer-reviewed Journals.

Key words: Cropping systems, *Fusarium* spp., mycotoxins, plant residues, wheat

Résumé

Le projet envisagé vise à évaluer le rôle des résidus de récolte, des systèmes de culture et de la diversité d'espèces fongiques sur la contamination par les mycotoxines du blé. Menées avec les producteurs de blé, le projet vise à recommander des systèmes de culture appropriés pour les petits agriculteurs et, finalement, de réduire les niveaux d'inoculum de *Fusarium*, d'augmenter la production du blé et d'améliorer la santé humaine et animale en réduisant l'exposition aux mycotoxines. Deux étudiants du Master seront directement impliqués dans la mise en œuvre des activités proposées, en acquérant de compétences dans l'analyse des mycotoxines et sur l'identification des espèces de *Fusarium* morphologiquement complexes. Le projet publiera une brochure qui peut être utilisé par les producteurs du blé et Le personnel de vulgarisation, tandis que la communication à la

communauté scientifique se fera à travers des publications dans des revues scientifiques.

Mots clés: Systèmes de culture, *Fusarium* spp., les mycotoxines, les résidus végétaux, le blé

Background

Fusarium head blight (FHB) has re-emerged as a devastating disease of wheat and other small-grain cereals throughout the world (McMullen *et al*., 1997). Research on FHB and associated mycotoxins in East Africa is still at infancy. The disease causes quantitative and qualitative reduction in yield, increased cost of production and mycotoxin contamination, which poses a health risk to humans and livestock. The disease is further complicated by complexity of the causal agent involving more than 19 *Fusarium* species, which produce different mycotoxins (Wagacha *et al*., 2010). It is therefore important to establish the diversity of mycotoxigenic fungi in wheat production systems in Kenya in order to assess the risk of mycotoxin contamination of wheat and the level of exposure to humans.

Fusarium spp. survive in infected wheat debris and provide primary inoculum for FHB in a new crop (Guo *et al*., 2010). It is therefore paramount to establish the level of *Fusarium* colonization and diversity in wheat/cereal residues in order to: assess the level of risk of infection of subsequent wheat crops which is important for long-term FHB forecasting and management; establish the role of plant residues in the survival and spread of *Fusarium* spp.; and adopt appropriate FHB management strategies. The proposed study will also assess the role of wheat cropping systems – wheat monoculture and mixed cropping – in FHB. The main objective of the study will be to establish the link between wheat cropping systems, fungal diversity and mycotoxin contamination of wheat.

Literature Summary

Although more than 19 *Fusarium* species have been implicated in FHB, *F. graminearum*, *F. culmorum*, *F. poae* and *F. avenaceum* and *Microdochium nivale* are the most common pathogens of wheat associated with FHB worldwide (Parry *et al.*, 1995). The wide *Fusarium* spp. diversity has implications on the spectrum of mycotoxins contaminating human food and animal feed. Mycotoxin contamination of wheat in Sub-Saharan Africa is exacerbated by the tropical climate - high humidity and temperature - which creates optimal conditions for fungal growth. Without intervention on *Fusarium* infections and related mycotoxin contamination, there is a danger of compromised food and feed quality.

Wheat can be infected by *Fusarium* spp. during all growth stages, although anthesis is the most susceptible and economically important developmental stage for head blight infections (Sutton 1982). *Fusarium* spp. overwinter in infected crop debris on which they produce ascospores or conidia (or both), which are then dispersed by wind or splashing to new infection courts providing primary inoculum (Guo *et al.*, 2010). However, few studies have investigated infection of vegetative wheat parts during the growth period and the role of crop debris in the survival and spread of *Fusarium* spp. between cropping seasons. It is therefore necessary to understand the role of infection of straw fractions in FHB cycle; pathogen survival and spread; and mycotoxin-associated health risk posed to consumers of contaminated kernels.

Study Description

The proposed project will be implemented in two major wheat growing districts - Nakuru and Mau Narok – of Kenya with diverse agro-ecological regions. Both large and small scale farms will be randomly selected in different agro-ecological zones (AEZ) by selecting the fifth wheat-growing farm in a transect. The selection criteria will also consider farms either rotating wheat with maize or practicing mixed farming of the two crops. The selected farmers will be briefed on the project objectives and only consenting members will be engaged. Microbiological studies and mycotoxin analysis will be carried out in laboratories at the School of Biological Sciences, University of Nairobi and Kenya Agricultural Research Institute (KARI) in Nairobi, Kenya. The project will have a three-pronged approach of increasing returns from wheat production; improved food and nutritional security; and improved human health.

Wheat farming communities in the two study regions will be engaged through interviews with a view to establishing their understanding of wheat production practices, their knowledge on FHB and challenges that they encounter in wheat production. Implementation of the project will be centered on two Master of Science (M.Sc.) students, a female and male candidate. “Student 1” will investigate the role of sources of primary FHB inoculum in development of the disease and mycotoxin contamination. Analysis of major mycotoxins - deoxynivalenol, nivalenol, T2-toxin and HT2-toxin - will be by direct competitive Enzyme-Linked Immunosorbent Assay (ELISA, AOAC, 1995) “Student 2” will determine the diversity of *Fusarium* spp. and other fungal pathogens associated with FHB of wheat and

correlate their incidence with mycotoxin types and levels. Polymerase chain reaction (PCR) will be carried out for partial sequencing of translation elongation factor 1-alpha (*tef*) gene of representative isolates of *Fusarium* species which will not be reliably identified based on cultural and morphological characteristics.

Research Application

The major outcomes expected from the project include:

i. Training of two scientists at M.Sc. level to acquire competent skills in isolation and identification of *Fusarium* spp. and mycotoxin analysis.
ii. End of project workshop to train extension personnel in the two study districts on management of FHB and risk of associated mycotoxins.
iii. Enhanced awareness and practical skills among farmers and extension personnel on FHB and possible management strategies. This will be achieved through a stakeholders' workshop.
iv. Enhanced awareness on health implications of mycotoxins to humans.

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