Research Application Summary pp: 213 - 217

# Role of soil and crop residues as sources of inoculum for *Fusarium* head blight of wheat

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## Abstract

A field survey was carried out in Narok County, Kenya, at hard dough growth stage (GS 65-69) during the 2013 cropping season and sampling done in 51 wheat farms in different agro-ecological zones. Samples of soil and crop residues were collected in each farm for isolation of *Fusarium* head blight (FHB) pathogens. Isolation of *Fusarium* spp. from the crop debris and soil was done on low strength potato dextrose agar modified with minerals and antibiotics and the fungi identified based on their morphological and cultural characteristics. The major *Fusarium* spp. isolated from soil were *F. oxysporum* and *F. proliferatum* while *F. chlamydosporum* while *F. graminearum* were isolated from crop residues. The incidence of *Fusarium* spp. in crop residues and soil significantly (p d" 0.05) varied among agro-ecological zones (AEZs). The high prevalence of FHB in Narok County could be linked to the high incidence of *Fusarium* spp. in crop residues and soil.

Key words: Crop residues, *Fusarium* head blight, soil

## Résumé

Une enquête de terrain a été effectuée dans le comté de Narok, Kenya, à une étape dure de croissance (GS 65-69) au cours de la campagne agricole 2013 et l'échantillonnage ont été effectué dans 51 exploitations de blé dans les différentes zones agro-écologiques. Les échantillons de résidus de sol et de culture ont été prélevés dans chaque exploitation pour l'isolement des pathogènes de *Fusarium* (FHB). L'isolation de *Fusarium* spp. A partir des débris de cultures et le sol a été fait sur la gélose faible résistance de patate dextrose modifié avec des minéraux et des antibiotiques et les champignons identifiés sur la base de leurs caractéristiques morphologiques et culturelles. Le principal *Fusarium* spp. isolé du sol étaient *F.* et *F. oxysporum proliferatum* tandis que *F. chlamydosporum* et *F. graminearum* étaient isolés à partir de résidus de récolte. L'incidence de *Fusarium* spp. des résidus de culture et les sols de façon significative (pd "0,05) variait entre zones agro-écologiques (ZAE). La prévalence élevée de la *Fusarium* dans le comté de Narok pourrait être liée à la forte incidence de *Fusarium* spp. dans les résidus de cultures et des sols.

Mots clés: résidus de culture, la tète de mildiou *Fusarium*, le sol

## Background

Wheat (*Triticum aestivum*) is the second most important cereal grain in Kenya after maize (Gamba *et al.,* 2012), with an annual production of only 350,000 metric tons against a consumption of 900,000 metric tons per year (Odhiambo, 2012). Infection of wheat by *Fusarium* spp. is a major challenge to wheat production resulting in *Fusarium* head blight (FHB), an economically important disease (Niaz and Dawar, 2009). The disease is caused by a complex of soil and residue borne *Fusarium* species; *F. graminearum, F. poae, F. avenaceaum, F. culmorum* (Parry *et al*., 1995) which can infect wheat during all growth stages although anthesis is the most susceptible stage when moisture exceeds 20% and relative humidity exceeds 90% (Tomohiro and Kazuhiro, 2000).

## Literature summary

*Fusarium* head blight reduces grain yields, grain quality and contaminates the grains with mycotoxins (Keller, 2011). Previous studies have shown that FHB is present in Kenya (Wagacha *et al*., 2010; Muthomi *et al*., 2012). The pathogen is capable of surviving as a saprophyte on crop debris and contributes to inoculum for infection of wheat plants in the same field in which the residue is present and more distant fields (Keller, 2011). Crop residues left in the field increase the population of *Fusarium* spp. in soils (Dill-Macky and Jones, 2000). This study, therefore, investigated the role of crop residues and soil as sources of inoculum and its effect on incidence and severity of FHB of wheat.

## Study description

A field survey was carried out in Narok County, Kenya, at hard dough growth stage (GS 65-69) during the 2013 cropping season and sampling done in a transect in 51 wheat farms in three agro-ecological zones (AEZ); 15 wheat farms in lower highland 3 (LH3), 18 in lower highland 2 (LH2), and 18 in upper highland 3 (UH3).The number of farms were determined according to the number of wheat farmers in each AEZ. *Fusarium* head blight incidence and severity were determined in five $1m^2$ randomly selected quadrants in each farm. Samples of soil and crop residues were collected in each farm for isolation of FHB pathogens. Soil was collected from top 5cm, where fungal population is expected to be higher, from five different points in each farm and mixed to make a composite sample from which 100g sub-sample was taken. Isolation of *Fusarium* spp. from the crop debris and soil was done on low strength potato dextrose gar (PDA) modified with minerals and antibiotics (Muthomi *et al*., 2002). Colonies of *Fusarium* spp. growing on crop debris and soil were sub-cultured on PDA and synthetic nutrient agar (SNA, Nireberg, 1981) and identified based on cultural and morphological characteristics (Nelson *et al.,* 1983; Leslie and Summerell, 2006). All the data obtained were subjected to Analysis of Variance and differences among the treatment means compared at 5% probability level.

## Research application

The major *Fusarium* spp. isolated from soil and crop residues are shown in Table 1. The incidence of *Fusarium* spp. in crop residues and soil significantly (p d" 0.05) varied among the AEZs. *Fusarium* head blight was found in all the farms surveyed but disease incidence and severity varied among the AEZs (Table 2). *Fusarium* head blight inocula can survive in

**Table 1. Prevalence, incidence and severity of FHB of wheat in different agro-ecological zones in Narok County, Kenya.**

| AEZ | Incidence (%) | Severity [a] |
|---|---|---|
| LH3 | 20.7b | 3.9a |
| LH2 | 25.1ab | 4.2a |
| UH3 | 39.4a | 3.8a |
| Mean | 28.4 | 4.0 |
| L.S.D. (p< 0.05) | 17.2 | 1.3 |
| CV (%) | 85.1 | 47.3 |

[a]Severity score bSeale by agro-ecological zones in d.Table or Figure to guide the reader where presented in form of a graph or table. Reference ased on scale by Miedaner *et al.* (1996): 1 = no symptoms, 2= <5%, 3 = 5-15%, 4 = 16-25%, 5 = 25-44%, 6 = 46-65%, 7 = 66-85%, 8 = 86-95%, 9 = 96-100%.

**Table 2. Isolation frequency (%) of *Fusarium* spp. in soil (A) and crop residues (B) sampled from wheat fields in different agro-ecological zones in Narok County. .**

(A)

| *Fusarium* spp. | Agro-ecological zones | | | Mean |
|---|---|---|---|---|
| | LH3 | LH2 | UH3 | |
| Fox | 3.0a | 2.2ab | 5.1a | 3.4a |
| Fpro | 2.2ab | 2.9a | 2.5b | 2.5b |
| Fsa | 1.8abcd | 1.5b | 1.5bc | 1.6c |
| Feq | 0.2de | 0.4c | 1.6bc | 0.7de |
| Fch | 0.3cde | 0.0c | 0.9bc | 0.4d |
| Fgr | 0.3cde | 0.2c | 0.5c | 0.4d |
| Fsc | 0.2de | 0.3c | 0.3c | 0.3d |
| Fso | 0.4bcde | 0.1c | 0.0c | 0.2d |
| Fvert | 0.3cde | 0.1c | 0.2c | 0.2d |
| Fni | 0.0e | 0.2c | 0.0c | 0.1d |
| Other | 2.1abc | 0.5c | 1.2bc | 1.3cd |
| Mean | 1 | 0.8 | 1.3 | 1 |
| LSD (p<0.05) | 1.84 | 0.97 | 1.64 | 0.87 |
| CV (%) | 109 | 74.7 | 76.7 | 91.6 |

(B)

| *Fusarium* spp. | Agro-ecological zones | | | Mean |
|---|---|---|---|---|
| | LH3 | LH2 | UH3 | |
| Fch | 4.3a | 2.2ab | 1.2c | 2.6a |
| Fgr | 1.8b | 2.9a | 1.3c | 2.0ab |
| Feq | 0.1e | 2.0ab | 3.7a | 1.9ab |
| Fsa | 0.7de | 1.5cd | 2.5b | 1.6bc |
| Fsc | 1.5bc | 0.1e | 0.7cd | 0.8cd |
| Fav | 0.4e | 0.7de | 1.1b | 0.7e |
| Fox | 0.4e | 0.0e | 0.9cd | 0.4e |
| Fso | 0.3e | 0.6cd | 0.1e | 0.3e |
| Fse | 0.0e | 0.4e | 0.5cd | 0.3e |
| Fsub | 0.7de | 0.0e | 0.1e | 0.3e |
| Ftri | 0.1e | 0.2e | 0.0e | 0.1e |
| Mean | 0.9 | 0.9 | 1 | 0.9 |
| LSD (<0.05) | 1.01 | 1.03 | 0.94 | 0.83 |
| CV (%) | 68.4 | 68.4 | 55.6 | 96.1 |

Means followed by different letters within columns are significantly different (p <0.05).
Fox: *F. oxysporum*, Fpro: *F. proliferatum*, Fsa: *F. sambucinum*, Feq: *F. equiseti*, Fch: *F. chlamydosporum*, Fgr: *F. graminearum*, Fsc: *F. scirpi*, Fso: *F. solani*, Fvert: *F. verticillioides*, Fni: *F. nivale*, Fav: *F. avenaceum,* Fse: *F. semitectum*, Fsub: *F. subglutinans*, Ftri: *F. tricinctum.*

the soil implying that soil could be a potential source of FHB inocula as well as inocula for other crop diseases (Keller, 2011). In soil, *Fusarium* spp. persists as mycelia, chlamydospores and conidia (McMullan and Stack, 1983). When moisture and temperature are favorable, *Fusarium* spp. could provide primary FHB inocula especially at anthesis when wheat is most susceptible to the disease. The high prevalence of FHB in Narok County could be linked to the high incidence of *Fusarium* spp. in crop residues and soil. High population of *Fusarium* spp. on crop residues and agricultural soil could impact on crop health and consequently on the quantity and quality of human and livestock foods and feeds, respectively. There is need, therefore, to develop strategies for better handling or removing of crop residues from fields after harvest. This will reduce primary inocula and consequently the amount of FHB and other *Fusarium* diseases of wheat.

LH3 - lower highland 3; LH2 - lower highland 2; UH3 - upper highland 3**,** LSD – Least significant difference; CV – coefficient of variation; other – unidentified *Fusarium* spp.

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