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Effect of farming practices on the occurrence of scab of wheat and its management through cultivar resistance

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Abstract

A survey was carried out in Nakuru and Narok Counties at hard dough stage and at harvest. A semi structured questionnaire was used to collect information on wheat production practices. *Fusarium* head blight incidence and severity in each farm were determined. *Fusarium* spp. were isolated from kernels at harvest by plating on low strength potato dextrose agar modified with minerals and antibiotics. The fungi were identified based on their morphological and cultural characteristics. Host resistance was determined and the area under disease progress curve (AUDPC) was calculated. Majority of the farmers in the two Counties were small scale who rotated wheat with maize or grew wheat in the same fields in consecutive years. The prevalence of FHB in the two Counties was 100%. *F. tricinctum* and *F. poae* were the most common *Fusarium* spp. in wheat kernels sampled from Narok at harvest while the corresponding species in wheat from Nakuru County were *F. avenaceum* and *F. graminearum.* All the wheat varieties and lines tested were susceptible to *F. graminearum* although the level of susceptibility differed. The study indicated that farming practices and varieties greatly contribute to the occurrence of FHB. Therefore, there is need to promote farming practices that would reduce sources of primary inocula for FHB; as well as undertake breeding for resistance of wheat cultivars for better management of the disease.

Key words: Cultivar resistance, farming practices, *Fusarium* head blight

Résumé

Une enquête a été réalisée dans les comtés de Nakuru et de Narok au stade pâteux dur et à la récolte. Un questionnaire semi structuré a été utilisé pour recueillir des informations sur les pratiques de production de blé. L'incidence de la fusariose de *Fusarium* et la gravité dans chaque exploitation ont été déterminées. Les *Fusarium* spp. ont été isolés à partir de grains à la récolte par étalement sur gélose faible résistance de patate dextrose modifié avec des minéraux et des antibiotiques. Les champignons ont été identifiés sur la base de leurs caractéristiques morphologiques et culturelles. La résistance qui accueille a été déterminée et l'aire sous la courbe de progression de la maladie (AUDPC) a été calculée. La majorité des agriculteurs dans les deux comtés étaient des petits exploitants qui faisaient des rotations de blé avec du maïs ou plantaient du blé et du maïs dans les mêmes champs dans les années consécutives. La prévalence de la FHB dans les deux comtés était de 100%. *F.*

tricinctum et *F. poae* étaientt les Fusarium spp les plus courants dans les grains de blé de l'échantillon de Narok à la récolte, tandis que les espèces correspondantes dans le blé du comté de Nakuru étaient *F. avenaceum* et *F. graminearum*. Toutes les variétés de blé et des lignées testées étaient sensibles à *F. graminearum* bien que le niveau de sensibilité soit différent. L'étude a indiqué que les pratiques et les variétés agricoles contribuent grandement à l'apparition de la FHB. Par conséquent, il est nécessaire de promouvoir des pratiques agricoles qui permettraient de réduire les sources d'inoculum primaire pour la FHB; ainsi que procéder à la sélection pour la résistance des cultivars de blé pour une meilleure gestion de la maladie.

Mots clés: résistance des cultivars, les pratiques agricoles, *Fusarium*

Introduction

Fusarium head blight (FHB) is an important disease of small grain cereals throughout the world. Numerous *Fusarium* spp. have been associated with FHB with *F. graminearum*, *F. culmorum, F. poae* and *F. avenaceum* being the most prevalent worldwide (Parry *et al*., 1995). These fungi are also associated with root rot, seedling blight and foot rot. *Fusarium* head blight is characterized by bleaching of wheat spikes, shriveled kernels and accumulation of mycotoxins in the grains. Such mycotoxins can contaminate animal feed and human food. Previous studies in Kenya showed that *Fusarium* spp. isolated from kernels and various vegetative plant parts of wheat (Wagacha *et al.,* 2010) causes economic losses. *Fusarium* head blight of wheat can be reduced through agronomic management practices including crop rotation, residue management, tillage system and timely application of fungicides (Ma *et al*., 2013). Among all these management options, the most promising management for FHB is breeding for resistance and deployment of resistant materials. Despite this, wheat cultivars grown in Kenya are susceptible to FHB and only a few are moderately resistant (Muthomi *et al*., 2002). This study therefore determined the effects of cropping systems on the occurrence of FHB and its management through resistant cultivars.

Materials and methods

A survey covering 102 wheat farms in different agro-ecological zones of Nakuru (Lower Highland 3, Upper Highland 3, Upper highland 2 and Upper highland 1) and Narok (Lower Highland 3, Lower Highland 2 and Upper Highland 3) Counties was carried out at hard dough stage and at harvest during the 2013 cropping season. A semi structured questionnaire was used to collect information on wheat production practices. *Fusarium* head blight incidence and severity in each farm were determined as the number of infected heads and the proportion of bleached spikelets in four $1m^2$ quadrants, respectively. *Fusarium* spp. were isolated by plating surface sterilized grains on low strength potato dextrose agar (PDA) amended with mineral salts and antibiotics (Muthomi *et al*., 2002). *Fusarium* colonies were sub-cultured on PDA and synthetic nutrient agar (SNA) and identified based on cultural and morphological characteristics (Nelson *et al*., 1983; Leslie and Summrell, 2006). Host resistance was determined by inoculating nine wheat varieties and four CYMMIT lines in field experiments with a mixture of four isolates of *F. graminearum.* Two field trials were conducted at

Nakuru Agricultural Training Centre (located in UM4 at S00.28088, E036.03308, 1885m ASL), and in a farmer's field in Narok County (located in UH2 at S00.78766, E035.89093, 2560 m ASL). The area under disease progress curve (AUDPC) was calculated from FHB severity data and kernel yield determined at harvest.

Results

Majority (67%) of wheat farmers in Narok and Nakuru Counties were small scale producers; where 58% of the farmers in Narok County used farm saved seeds while 74% of the farmers in Nakuru County used certified seeds from agro-shops and Kenya Agricultural Research Institute (KARI) (Table 1). In both Counties, more than 50% of the farmers practiced crop rotation. However, a bigger proportion (46%) of the farmers rotated wheat with maize while others grew wheat in consecutive years. Most (98%) farmers in Narok County used wheat straw and maize stovers as grazing hay for livestock. Only 8% of the farmers in Nakuru County ploughed in wheat residues. The prevalence of FHB in the two Counties was 100%. On average, incidence and severity of FHB was higher in Narok than in Nakuru County (Table 2). However, FHB was more severe in higher agro-ecological zones in both Counties. *F. tricinctum* and *F. poae* were the most common *Fusarium* spp. in wheat kernels sampled from Narok at harvest while the corresponding species in wheat from Nakuru County were *F. avenaceum* and *F. graminearum* (Table 3). All the wheat varieties and lines tested were susceptible to *F. graminearum* and the varieties exhibited

Table 1. Proportion (%) of farmers practicing various agronomic practices in Nakuru and Narok Counties.

Agronomic practice	Category	County	
		Narok	Nakuru
Farm sizes[a]	Small scale	65	68
	Medium scale	20	21
	Large scale	15	11
Source of seeds	Agro-shops	41	74
	Own	29	18
	Neighbor	29	8
Rotation program	Maize	32	59
	Short term crops	25	41
	Wheat in consecutive years	43	23
Residue management	Standing hay	98	20
	Hay bailing	0	61
	Ploughing in	0	8
	Others	2	11

[a] Farm sizes: < 8ha, small scale; 8 – 20 ha, medium scale; > 20ha, large scale.

Table 2. Incidence and severity of FHB of wheat in different agro-ecological zones in Narok and Nakuru Counties.

Agro-ecological zone	Incidence (%)		Severity[a]	
	Narok	Nakuru	Narok	Nakuru
LH3	20.7b	12.9a	3.9a	4.0a
LH2	25.1ab	-	4.2a	-
UH3	39.4a	11.8a	3.8a	4.0a
UH2	-	10.6a	-	3.0a
UH1	-	11.7a	-	4.0a
Mean	28.4	11.7	4.0	3.8
LSD ($p < 0.05$)	17.2	6.1	1.3	1.2
CV (%)	85.1	65.3	47.3	34.7

[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 3. Incidence (%) of *Fusarium* spp. isolated from wheat kernels at harvest in Narok and Nakuru Counties.

Fusarium spp.	County	
	Narok	Nakuru
F. tricinctum	4.4a	0.43c
F. poae	2.9a	1.04bc
F. equiseti	1.1a	-
F. nivale	1.1a	-
F. sambucinum	1.1a	-
F. graminearum	0.4a	2.4b
F. avenaceum	-	7.4a
F. solani	-	0.22c
F. culmorum	-	0.10c
Mean	1.8	1.93
LSD ($p<0.05$)	3.6	3.04
CV (%)	172.3	400

Means followed by the same letter within columns are not significantly different ($p<0.05$).

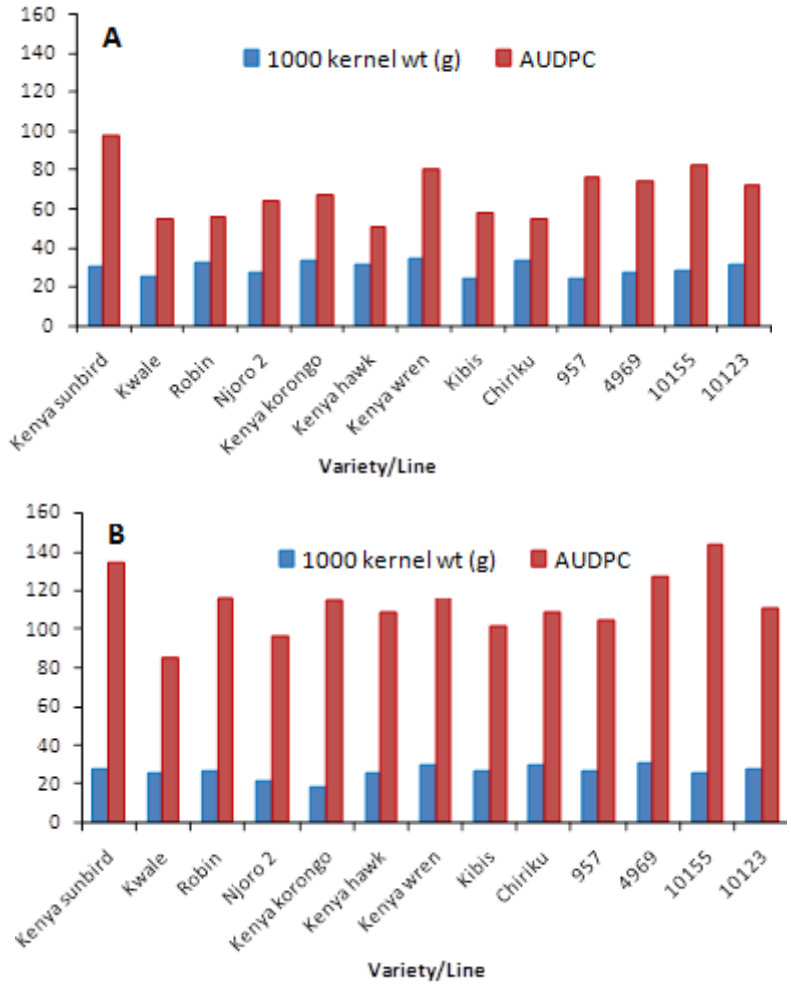

Figure 1. 1000 wheat kernel weight (g) and AUDPC of FHB on wheat; Nakuru Agricultural Training Centre (A), farmer's field in Narok County (B).

varying levels of susceptibility. There were significant differences (p dŠ 0.05) in AUDPC and 1000 kernel weight among the wheat varieties and lines (Fig. 1).

Discussion

Wheat production practices contribute to high FHB incidence and severity (FAO, 2001). Wheat and maize residues are sites for development of FHB inocula when weather conditions are favorable. *Fusarium* spp. overwinter in cereal debris from previous maize or wheat crops, especially when minimum or no tillage is practiced (Guo *et al*., 2010). The difference in incidence of FHB between the two Counties could be attributed to differences in farming practices as well as climatic conditions (Muthomi *et al*., 2012) while FHB high prevalence could be due to susceptibility of the wheat varieties coupled with the complex nature of the scab disease causative agents. Although FHB is caused by a complex of *Fusarium* spp.,

different species predominate in different regions (Parry *et al*., 1995; Wagacha *et al*., 2010). The wheat varieties and lines varied in FHB severity and kernel weight indicating differences in level of resistance.

Conclusion

Therefore, there is need to promote farming practices that would reduce sources of primary inocula for FHB; as well as undertake breeding for resistance of wheat cultivars for better management of the disease.

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References

Food and Agricultural Organization of the United Nations (FAO). 2001. Summary - farming systems and poverty: improving farmers' livelihoods in a changing world. FAO and World Bank, Rome and Washington DC.

Guo, X.W., Fernando, W.G.D., Bullock, P. and Sapirstein, H. 2010. Quantifying cropping practices in relation to inoculum levels of *Fusarium graminearum* on crop stubble. *Plant Pathology* 59:1107-1113.

Ma, B.L, Subedi, K.D, Xue, A.G. and Voldeng, H.D. 2013. Crop management effects on *Fusarium* head blight, *Fusarium*-damaged kernels and deoxynivalenol concentration of spring wheat. *Journal of Plant Nutrition* 36:717-730.

Muthomi, J.W., Musyimi, S.L., Wagacha, J.M. and Narla, R.D. 2012. Occurrence of *Fusarium* species and associated T-2 toxin in Kenyan wheat. *Agricultural Sciences* 3:24-34.

Muthomi, J.W., Oerke, E.C., Dehne, H.W. and Mutitu, E.W. 2002. Susceptibility of Kenyan wheat varieties to head blight, fungal invasion and deoxynivalenol accumulation inoculated with *Fusarium graminearum*. Journal of Phytopatholology 150: 30-36.

Parry, D.W., Jenkinson, P. and McLeod, L. 1995. *Fusarium* ear blight (scab) in small grains - A review. *Plant Pathology* 44:207-238.

Wagacha, J.M., Steiner, U., Dehne, H.W., Zuehlke, S., Spiteller, M., Muthomi, J. and Oerke, E.C. 2010. Diversity in mycotoxins and fungal species infecting wheat in Nakuru District, Kenya. *Journal of Phytopathology* 157:527-535.