RUFORUM Working Document Series (ISSN 1607-9345), 2018, No. 17 (2): 401-405.
Available from http://repository.ruforum.org

Research Application Summary

Effect of cropping pattern on the incidence of Sorghum downy mildew disease in Uganda

Kumi, F.[1,2], Ochwo-Ssemakula, M. [1], Tusiime, G.[1], Biruma, M.[3] & Rubaihayo, P.R.[1]

[1]Department of Agricultural Production, College of Agricultural and Environmental Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda
[2]Department of Crop Science, College of Agricultural and Natural Sciences, University of Cape Coast, P.M.B Cape Coast, Ghana
[3]National Semi-Arid Resources Research Institute (NaSARRI), Serere, Uganda
Corresponding author: frankkumifk@gmail.com

Abstract

Sorghum (*Sorghum bicolor*) is largely grown in Uganda as a subsistence food crop and it ranks as the third most important staple cereal food crop after maize and millet. Sorghum production is challenged by sorghum downy mildew (SDM) disease which is one of the most devastating diseases of sorghum. The disease is caused by an obligate soil-borne fungus *Peronosclerospora sorghi* which affects plants from seedling to flowering stage. Affected plants can result in 100 % yield loss when left uncontrolled. A survey was conducted on incidence and severity of downy mildew disease and the cropping pattern practiced in six districts across six agro-ecological zones in Uganda from September-December, 2015. Data on disease incidence and severity were collected and subjected to analysis of variance and the means were separated using Fisher's protected least significant difference ($P > 0.05$). Correlation was done for cropping pattern, disease incidence and severity to establish any association. From the study, significant ($P > 0.05$) differences were recorded for disease incidence and severity across the different districts reflecting the difference in environmental condition which affects the perpetuation and development of the disease. The mean downy mildew disease incidence varied significantly ($P > 0.05$) from 49.4 % for Pader to 63.4 % for Kabale. Disease severity also recorded significant difference ($P > 0.05$) from a score of 2.3 (Pader) recorded as the lowest to 2.7 (Arua) recorded as the highest score. No significant ($P > 0.05$) correlation was observed between disease incidence, severity and cropping pattern, however a weak positive correlation was observed between disease incidence and severity ($r = 0.357$) and disease incidence and cropping pattern recorded a strong non-significant correlation ($r = 0.701$). The observed variations in the incidence and severity of downy mildew disease makes it imperative to further screen sorghum genotypes to identify sources of resistance.

Key words: Incidence, *Peronosclerospora sorghi*, survey, Uganda

Résumé

Le sorgho (*Sorghum bicolor*) est largement cultivé en Ouganda comme culture vivrière de subsistance et se classe au troisième rang des cultures vivrières de céréales de base après le maïs et le millet. La production de sorgho est menacée par la maladie du mildiou du sorgho (SDM) qui est l'une des maladies les plus dévastatrices du sorgho. La maladie est causée par un champignon du sol obligatoire

Peronosclerospora sorghi qui affecte les plantes du stade des semis à la floraison. Les plantes affectées peuvent entraîner une perte de rendement de 100% lorsqu'elles ne sont pas contrôlées. Une enquête a été menée sur l'incidence et la sévérité de la maladie du mildiou et le mode de culture pratiqué dans six districts de six zones agro-écologiques en Ouganda de septembre à décembre 2015. Des données sur l'incidence et la sévérité de la maladie ont été collectées et soumises à une analyse de la variance et les moyennes ont été séparées en utilisant la différence la moins significative protégée de Fisher (P >0,05). Une corrélation a été effectuée pour le modèle de culture, l'incidence de la maladie et la gravité afin d'établir toute association. À partir de l'étude, des différences significatives (P >0,05) ont été enregistrées pour l'incidence et la gravité de la maladie dans les différents districts, reflétant la différence des conditions environnementales qui affecte la perpétuation et le développement de la maladie. L'incidence moyenne du mildiou variait significativement (P >0,05) de 49,4% pour Pader à 63,4% pour Kabale. La sévérité de la maladie a également enregistré une différence significative (P >0,05) d'un score de 2,3 (Pader) enregistré comme le plus bas à 2,7 (Arua) enregistré comme le score le plus élevé. Aucune corrélation significative (P >0,05) n'a été observée entre l'incidence de la maladie, la sévérité et l'arrangement de culture, cependant une faible corrélation positive a été observée entre l'incidence et la sévérité de la maladie (r = 0,357) et l'incidence de la maladie et l'arrangement de culture ont enregistré une forte corrélation non significative (r = 0,701). Les variations observées dans l'incidence et la sévérité de la maladie du mildiou rendent impératif un dépistage plus poussé des génotypes de sorgho pour identifier les sources de résistance.

Mots clés : Incidence, *Peronosclerospora sorghi*, enquête, Ouganda

Background

Sorghum (*Sorghum bicolor* [L.] Moench) is the world's fifth major cereal after maize, wheat, rice and barley in terms of worldwide production and acreage (FAO, 2013). It is a staple food crop for millions of the poorest and most food-insecure people in the semi-arid tropics of Africa, Asia and Central America (Reddy *et al.*, 2010). In Uganda, sorghum ranks as the third most important staple cereal food crop after maize and millet occupying over 400,000 ha of the total arable land with a yield of 380,000 metric tonnes (UBOS, 2010) but largely grown as a subsistence food crop with poor yields. The demand for sorghum of recent has increased due to the high demand from the beverage industries both locally and globally (Datta *et al.*, 2012).

Despite the economic importance sorghum production offers to the socio-economic well-being of farmer and broadly to the Gross Domestic Product (GDP), it's production and productivity is limited by myriad of biotic stresses of which sorghum downy mildew (SDM) is one those devastating diseases. Sorghum downy mildew (SDM) is a foliar disease caused by a soil-borne fungus *Peronosclerospora sorghi* but can also be air-borne through conidia. Affected plants show stunted growth, chlorotic leaf flecks, alternating parallel stripes of green to yellowish tissues and leaf shredding (Jeger, 1998). The disease can cause a yield loss ranging between 50 – 100 %. The disease is hypothesized to be influenced by favourable environmental conditions (rainfall, relative humidity, temperature) (Bigirwa *et al.*, 1999; Kumi *et al.*, 2018) which allows for conidia production and subsequent development of the disease (Bock *et al.*, 1999).

Additionally, agronomic practices such as time of sowing and cropping pattern also offer conducive microenvironments that can alter the level of disease development on their host plant (Olanya and Fajemisin, 1993). The objective of this study was to determine the effect of cropping pattern on the

prevalence of SDM disease in Uganda. The study will provide baseline information for designing an effective breeding programme which will also factor in agronomic practices to supplement host-plant resistance for sustainable sorghum production.

Material and methods

This study was conducted in six major sorghum growing districts of Uganda namely (Arua, Hoima, Kabale, Lira, Namutumba and Serere) across six agro-ecological zones during the second cropping season of 2015. A total of twenty sorghum farms were randomly selected from each district and assessed for SDM disease incidence and severity. In each farm, 50 sorghum plants were assessed for SDM disease symptoms such as necrotic leaves, chlorosis, downy appearance, leaf shredding, stunted growth and vein clearing (Jeger *et al.*, 1998). Plants showing SDM symptoms were counted and expressed as a proportion of percentage disease index (PDI) to the total number of plants assessed (Ward *et al.*, 1997).

$$PDI = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \times 100$$

Severity of SDM disease was assessed using a scale of 1 - 5 adapted from Ward *et al.* (1999), where 1 = no symptoms on leaves, 2 = 1- 25 % leaf area infection, 3 = 26-50 % leaf area infection, 4 =51-75 % and 5 = 76 -100 % leaf area infection.

Assessment of cropping patterns in farmers' fields took into consideration sorghum farms which have been intercropped with maize/sugarcane or both, as these crops serves as alternate host for *Perosclerospora sorghi*. Analysis of variance was carried out for disease incidence and severity and the means separated by least significant difference (LSD) using Genstat statistical package (Payne *et al.*, 2012). Correlation was performed between cropping pattern, disease incidence and severity.

Result and discussion

Table 1 shows correlation for disease incidence and severity with cropping pattern. There was no significant ($P<0.05$) correlation amongst the parameters, however, weak positive correlations of 0.356 and 0.349 were recorded between disease incidence and severity, and disease incidence and cropping pattern, respectively. A strong positive correlation ($r = 0.701$) was recorded between disease severity and cropping pattern.

Table 1. Correlation coefficients between downy mildew disease (incidence and severity) and cropping pattern

Parameters	Incidence (%)	Severity score	Cropping pattern
Incidence (%)	-		
Severity score	0.357	-	
Cropping pattern	0.349	0.701	-

The incidence and severity of SDM disease recorded differed significantly between the surveyed districts (Table 2). The highest incidence was recorded in Kabale (63%) which was significantly ($P<0.05$) higher than for the lowest disease incidence value recorded in Pader (49.4%). However, the incidence recorded in Masindi (59.8%), Arua (55.5%), and Serere (53.3%) were not significantly different from each other. Downy mildew disease severity was highest in Arua (2.79) and was significantly different ($P<0.05$) from Pader (2.31) which recorded the lowest severity. Severity recorded in Masindi (2.55), Kabale (2.56), Serere (2.69) and Hoima (2.69) were not significantly different from each other (Table 2).

Table 2. Mean separation for incidence and severity at the different locations of Uganda

District	Agro-ecological zones	Incidence (%)	Severity
Kabale	Southwestern highlands	63.6a	2.56ab
Masindi	Lake Albert crescent	59.8ab	2.55ab
Arua	West Nile	55.5bc	2.79a
Serere	Eastern highlands	53.3bc	2.69a
Hoima	Western mid-altitude	50.8c	2.69a
Pader	Northern grassland	49.4c	2.31b
LSD		7.5	0.25
CV %		21.6	15.5

Mean values with the same alphabet within a column are not significantly different ($P < 0.05$); CV = coefficient of variation; Lsd = Least significant difference

This study confirms findings by Bigirwa *et al.* (1998) and Kumi *et al.* (2018) who reported significant differences in incidence of the disease in Uganda. These significant differences can be attributed to differences in environmental factors (temperature, relative humidity and rainfall) across the different agro-ecological zones where the study sites are located (Kumi *et al.*, 2018). Additionally, cultivation of susceptible varieties/cultivars is also a contributory factor for the high disease incidence recorded.

Conclusion

Downy mildew disease was prevalent in all the surveyed sites and varied significantly with location in Uganda. From the study, cropping pattern (intercropping and mono-cropping) had no significant correlation with disease incidence and severity. There is a need to screen sorghum varieties for resistance to downy mildew disease as no resistant varieties are available in Uganda.

Acknowledgement

We are grateful to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and Intra-ACP CSAA Mobility Programme for the opportunity to share our research findings.This paper is a contribution to the 2018 sixth African Higher Education Week and RUFORUM 2018 Biennial Conference.

References

Bigirwa, G., Adipala, E. and Esele, J.P. 1998. Occurrence of Peronosclerospora sorghi in Uganda. *Plant Disease* 82: 757-760.

Bock C.H., Jeger M.J., Mughogho, L.K., Cardwell, K.F. and Mtisi, E. 1999. Effect of dew point temperature and conidium age on germination, germ tube growth and infection of maize and sorghum by Peronosclerospora sorghi. *Mycological Research* 103 (7): 859-864.

Datta, M.S., Poshadri, A., Srinivasa, R.P., Ravinder, R.C. and Reddy, B.V.S. 2012. Innovative use of sweet sorghum juice in the beverage industry. *International Food Research Journal* 19 (4): 1361-1366.

FAOSTAT (Food and Agriculture Organization of the United Nations). 2013. Production statistics: crops. FAO statistical databases, http://www.fao.org/faostat/en/#data/QC

Jeger, M.J. 1998. The effect of sowing date on the incidence of sorghum downy mildew in Zimbabwe. *Tropical Science* 39: 194-203.

Kumi, F., Agbahoungba, S., Badji A., Odong, T., Edema, R., Ochwo-Ssemakula, M., Nakubulwa D., Tusiime, G., Biruma, M. and Rubaihayo P. 2018. Incidence and distribution of downy mildew disease (Peronosclerospora sorghi) of sorghum in Uganda. *International Journal of Advanced Research* 6 (5): 954-965.

Olanya, O.M and Fajemisin, J.M. 1993. Host-range and survival studies of Peronosclerospora sorghi at two locations in Nigeria. *International Journal of Pest Management* 39 (1): 13-18

Payne, R.W., Murray, D.A., Harding, S.A., Baird, D.B. and Soutar, D.M. 2012. Genstat for Windows. 15th Edition, Introduction, VSN International, Oxford.

Reddy, B.V.S., Ashok, K.A. and Sanjana, R.P. 2010. Recent advances in sorghum improvement research at ICRISAT. *Kasetsart Journal (Natural Science)* 44: 499-506.

UBOS. 2010. Uganda Census of agriculture 2008/ 2009.Volume IV: Crop Area and Production Report. 54pp.

Ward, J.M.J., Laing, M.D. and Rijkenberg, F. J. 1997. Determining incidence and severity if downy mildew disease in Maize and Sorghum. *Plant Disease* 81: 41-48.

Ward, J.M.J., Stromberg, E.L., Nowell, D.C. and Nutter, Jr. F. 1999. Grey leaf spot: A disease of global importance in maize production. *Plant Disease* 83: 884 - 895.