ARTICLE IN PRESS

Crop Protection xxx (2016) 1–8

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Cowpea scab disease (*Sphaceloma* sp.) in Uganda

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ARTICLE INFO

Article history:
Received 20 October 2015
Received in revised form
29 June 2016
Accepted 30 June 2016
Available online xxx

Keywords:
Vigna unguiculata
Sphaceloma sp.
Elsinoe
Incidence
Severity
Distribution

ABSTRACT

Cowpea (*Vigna unguiculata* L. Walp) is the third most important legume food crop in Uganda. It is the main legume food crop in the Eastern and Northern regions of the country, however, its mean yield is less than 400 kg ha^{-1}. Scab (*Sphaceloma* sp.) which is a seed-borne disease is one of the major constraints of cowpea production in the country, capable of causing yield losses of up to 100%. Cowpea scab is the anamorph of *Elsinoe phaseoli* in common bean (bean scab). The disease affects all the above ground parts of the cowpea plant. A study was conducted in the country to determine the incidence, severity and distribution of scab disease in 17 cowpea growing districts across three agro-ecological zones over a two year period. The results indicated that scab disease was widespread in all the districts with mean incidence ranging between 35 and 70% and mean severity 2–4. Tororo and Amuria districts had the highest incidence and severity, while Bukedea and Arua districts recorded the least disease incidence and severity. Cowpea fields located at altitudes above 1200 m.a.s.l had the highest mean disease incidence (82%) and severity (score = 3.4), while fields located on altitudes lying between 771 and 990 m.a.s.l registered the least disease incidence (64.7%) and severity (score = 2.7). The type of cultivar grown and cropping system practiced influenced the incidence and severity of the scab disease. The results of this study also showed that scab had high incidence and severity across districts and altitudes in Uganda suggesting the need to develop resistant cultivars. This indicates the need to establish the variability of the pathogen to inform the breeding programme for development of resistant varieties.

1. Introduction

Cowpea (*Vigna unguiculata* L. Walp) is the most economically important indigenous African legume crop (Langyintuo et al., 2003). It is grown in more than 60 countries either as a food crop or cash crop (Davis et al., 1991) occupying parts of Asia and Oceania, the Middle East, Southern Europe, Africa, Southern USA, Central and South America (Singh et al., 2003). According to Ba et al. (2004), Africa is the main area of production, where the crop is very important for low input agriculture which is a characteristic of most parts of the continent.

In Uganda, cowpea is the third most important legume food crop after the common beans (*Phaseolus vulgaris* L.) and groundnuts (*Arachis hypogea* L.), however, it is the main legume food crop in the Eastern and Northern regions (Nabirye et al., 2003) where it accounts for most of the production in the country (FAO, 1997). The mean yield of the crop is less than 400 kg ha-1 (CCRP, 2012) with annual production estimated at 20,000 t/yr.

Cowpea farmers face several adverse factors in growing the crop (Asiwe et al., 2005) for example, in Nigeria (Singh et al., 2003) and Uganda (Rusoke and Rubaihayo, 1994) where diseases are a major production constraint. Insect pests have also been reported as a major production constraint in Uganda (Karungi et al., 2000) and Nigeria (Singh et al., 2003). According to Allen (1983), about 40 species of fungi are pathogens of cowpea. Mbong et al. (2012), described scab as one of the most destructive diseases of cowpea that was capable of causing yield losses of up to 100% in epidemic infections. Cowpea scab (*Sphaceloma* sp.) is the anamorph of *Elsinoe phaseoli* in common bean (bean scab). Allen (1983) suggested that scab of cowpea is widespread in Tropical Africa and is a major disease in Savannah areas, and is seed-borne. The disease affects all the above ground parts of cowpea (Plate 1). Symptoms of leaf infection include the appearance of spots on both leaf surfaces and

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http://dx.doi.org/10.1016/j.cropro.2016.06.024
0261-2194/

cupped, small greyish scab lesions along the veins (Iceduna, 1993). The lesions coalesce and cause distortions or rugged appearance under severe infections. Infected stems show oval to elongated silver grey lesions surrounded by red or brown elliptical rings while infected pods show sunken spots with grey centres surrounded by brown borders, malformations, and dark coloured pycnidia formed in the brown spots (Singh and Allen, 1979). Conditions conducive for disease development have been described as moderate temperatures of about 23–28 °C, with three or more consecutive days of wet weather resulting in high relative humidity (Emechebe, 1980).

Though disease assessment is one of the most challenging tasks in working with plant diseases, it is the most important task in the study of plant diseases (Campbell and Neher, 1994). The incidence and severity of fungal diseases, as well as the prevalence rates have been found to be influenced by many factors. These factors have broadly been categorized into three which are, factors relating to the host plant, the pathogen and the environment (Agrios, 2005). The occurrence and the intensity of the disease are dependent on how these three factors interact. However, environmental factors have traditionally been considered to have the most impact on disease development (Keane and Kerr, 1997). According to Cooke and Whipps (1993), infection and disease occurrence on plants due to air-borne fungi are favoured by temperatures ranging between 15 and 40 °C. Atmospheric moisture is generally the single most important environmental factor influencing the incidence and severity of fungal diseases on plants (Talley et al., 2002).

Practices such as the planting density has also been found to affect the incidence and severity of fungal diseases. Gautam et al. (2013) indicated that an increase in biomass can modify the microclimate and affect the risk of infection. On the whole, an increase in plant density is said to increase the duration of leaf surface wetness and regulate temperature, thereby making infection by foliar pathogens more likely (Yáñez-López et al., 2012; Gautam et al., 2013). The recommended spacing for cowpea has been given as 50 × 20, 75 × 20 and 75 × 30–50 cm for erect, semi-erect and creeping types respectively (Dugje et al., 2009). The cultivar of cowpea grown, the source of seeds for planting and other husbandry practices may also influence disease incidence and severity (West et al., 2001). Studies on the scab disease in Uganda commenced in 1988 when the disease was reported to be rife in the Country in the preceding years (Takan, 1988). Successive studies on the disease were carried out by Iceduna et al. (1994), Nakawuka and Adipala (1997) and Tumwegamire et al. (1998) but since then, no other studies on the disease was considered until resurgence of the disease in the Country in 2010 necessitating further research on the disease by the National Semi-Arid Resources Research Institute (NaSARRI) and to develop resistant varieties to the disease as there is currently no improved cultivar resistant to the disease in the Country. There was therefore a need to conduct studies on the occurrence and distribution of the scab disease under different ecological zones in the major cowpea growing areas of Uganda to generate information that will serve as basis for the breeding programme.

2. Methodology

Field surveys were conducted in two years (2013 and 2014) within the major cowpea growing areas in Uganda. Fifteen districts were surveyed in 2013 (Fig. 1a.) while 14 districts were surveyed in 2014 (Fig. 1b). Twelve districts were common to both years of study while five districts (three for 2013 and two for 2014) had only one year data (two seasons combined). The dropping or adding of new districts in the 2014 study were based on new reports received on high occurrence of the disease on some farmers' fields within some Districts which were not covered in 2013. A total of 17 districts covering three (3) Agro-ecological Zones were surveyed. Districts under the Eastern Agro-ecological Zones (EAEZ) were surveyed in May 2013 and November 2014 while the districts within the North-Eastern Savanna Grasslands (NESG) and North-Western Savannah Grassland (NWSG) were surveyed in November 2013 and December of 2014 reflecting the differences in time of planting across the regions and the need to take observations at mid-podding stage. The average rainfall for the EAEZ, NESG and NWSG are 875 mm–1125 mm, 1250 mm–1500 mm and 875 mm–1250 mm respectively (NEMA, 2009). The number of districts surveyed under the various Agro-Ecological Zones were chosen in consultation with the Cowpea Breeding Programme at the National Semi-Arid Resources Research Institute (NaSARRI) on the basis of the size of the Agro-Ecological Zones and the areas where the cowpea crop is mostly grown in the districts. A total of 87 Sub-Counties (45 in 2013 and 42 in 2014) were selected across the districts and from each Sub-County, three cowpea farms were selected based on the purposive sampling technique of Gray et al. (2007). In all, a total of two hundred and sixty one (261) cowpea farms were surveyed. Data were collected on the incidence and severity of scab disease at three different sampling points on each of the farms. Other data collected were the cropping system employed, previous crop on the field, the variety cultivated, field planting distances and the type of crop/plants surrounding the field. Global Positioning System (GPS) readings of latitude, longitude and altitude were recorded for each location where data were collected.

2.1. Data analysis

Twenty (20) plants were observed for the presence of scab disease symptoms by taking a transact walk across the field and earmarking three sampling points which were 10 m apart along the transact (Ddamulira et al., 2014). Disease incidence was expressed as the percentage of infected plants over the 20 plants within the sampling point. Scab disease severity was scored using a scale of 1–5, where 1 = no symptoms, 2 = less than 10% infection, 3 = 10–20% infection, 4 = 20–50% infection, and 5 = more than 50% infection (Tumwegamire et al., 1998). Infected leaves and pods where available, were collected from each sampling point and wrapped in absorbent tissue and further wrapped in aluminium foil and kept on ice for pathogen isolation in the laboratory as shown in Plate 2A–D.

Scab disease incidence and severity maps were developed using GPS survey data points obtained from each sampling location and incidence and severity means generated from data analysis (Ddamulira et al., 2014). Correlation between incidence and severity means was done according to Payne et al. (2011) and data points were transformed into a point map using Ilwis 3.2 software (Toxopeus, 1997). The maps were exported and visualised in Arc View® GIS3.2 software (Rockware Inc). Disease incidence data was transformed using arcsine transformation of arcsine percentage (Gomez and Gomez, 1984) following a Kurtosis-Skewness test which showed a significant difference from the normal and the transformed data was analysed using Genstat edition 14 (Payne et al., 2011). Scab disease incidence and severity means were separated using Fisher's protected Least Significant Difference (LSD) test at $P < 0.05$. Chi-square test for independence or association of incidence and severity data with altitude was done in Genstat using the maximum likelihood method because it is more accurate (Payne et al., 2003). Cluster analysis was performed using R statistical package version 3.1.2 for windows. Clustering was done using Euclidean distances generated and the average method was used to generate hierarchical clusters.

Please cite this article in press as: Afutu, E., et al., Cowpea scab disease (*Sphaceloma* sp.) in Uganda, Crop Protection (2016), http://dx.doi.org/10.1016/j.cropro.2016.06.024