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Assessment of Asian soybean rust (*Phakopsora pachyrhizi*) disease severity in selected districts of Western Kenya

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Abstract

Soybean rust caused by the fungus *Phakopsora pachyrhizi*, is a major constraint to soybean production all over the world. The disease has significant impacts on the yield seed size and quality. The pathogen was reported in Kenya for the first time in 1996 and it is increasingly threatening soybean production, however no significant data has been collected on the level of infections in the soybean growing areas in Kenya. The disease severity was assessed in Khwisero, Butere, Mumias and Teso Districts of Western Kenya. The study revealed that the Soybean rust disease is prevalent in all the districts with the percent disease index (PDI) ranging from 40.37 to 74.8. There was no significant difference in the disease severity level in all the four district at $p<0.05$. The results of this study shows that more disease control measures needs to be applied to ensure that the farmers get maximum yields from the crops.

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Introduction

The cultivation and utilization of soybean locally and at industrial level in Kenya has continued to grow and is probably motivated by the search for alternative sources of proteins and cooking oil (Nassiuma and Wasike 2002). The main soybean producing areas in Kenya Soybean is produced in Western, Nyanza, Rift valley as well as Central and Eastern provinces (Mahasi *et al.,* 2011). In 2011 the average production of soybean in Kenya was 2,000-5,000, however the industrial demand is at average of 120,000 MT in 2011 of (FAO, 2011). The current yield is within an average yield of 0.8 t/ha against a potential of 1.5 – 3.0 t/ha, depending on the location (Mahasi *et al.*, 2011). Low yields in the tropics are attributed to a number of biological and socio economic constrains. Insect pest, diseases, pod shattering, sensitivity to photoperiod and environment, and non-adoption of appropriate management practices are some of the key biological constrains. Lack of awareness of soybean utilization and markets are the major socio-economic limitations to soybean production in Africa (Kawuki *et al.*, 2003). Among the biological constraints diseases are by far the most important (Hartman *et al.*, 1999). Crop losses due to diseases significantly reduce the amount of food available for human and animal consumption, thus contributing directly to food insecurity and poverty. They also negatively affect internal and external marketing and trade in agricultural products, reduce farmers' incomes, and block poverty alleviation (FAO, 2005).

Soybean rust (*Phakopsora pachyrhizi*) particularly is the most destructive foliar disease of soybean in recent times. The pathogen which was initially restricted to Eastern Asian and Australia has spread significantly over the years (Pivonia and Yang, 2004). Its introduction into Africa was proposed to occur through urediniospores blowing from Western India to the African East Coastal areas by moist northeast monsoon winds (Levy, 2005). The disease was reported in Kenya, Rwanda and Uganda for the first time in 1996. It spread southwards to Zambia and Zimbabwe in 1998, Mozambique in 2000 and South Africa in 2001 (Kawuki *et al.*, 2003). Losses due to soybean rust can be significant. South Africa has experienced losses of 10-80% and in areas that use monocropping the loss may be as high as 100%. Losses experienced by India have been 10-90%, 40% in Japan, and 23-90% in Taiwan (Hartman *et al.* 1999).

The disease is visualized as small, tan-colored lesions formed mainly on the abaxial surface of soybean leaflets. Which leads to leaf chlorosis, premature defoliation and early maturity resulting in significant yield losses (Hartman *et al.*, 2005). Disease severity assessment is important in determing its effect on the final yield and quality of the crop produced. In Kenya the disease is often observed in the farmers fields however its damage and economic impact has not been established. The main objective of this study was to determine the severity of rust disease in farmers fields within western Kenya region.

Materials and methods

Study area

This study was conducted in Western Region of Kenya coordinates 0°30′N 34°35′E / 0.500°N 34.583°E / 0.500. Field survey for soybean rust was conducted in Khwisero, Butere , Mumias and Teso Districts during 2012/2013 planting period.

Sampling procedure

From each district twenty farms were randomly chosen for the survey. Sampling in each farm was done using a W-pattern whereby 20 plants from 5 different locations within the W- pattern were observed for presence of rust lesions. For each plant selected the top, middle and bottom canopy were assessed.

Disease severity assessment

The severity assessment was done on a scale of 1 to 9 the method published by Miles *et al.* 2005 (Table 1) where a rating of 1 means no soybean rust present on any leaflet, and a rating of 9 means greater than 20% of the leaflet surface infected by rust). The scales were further converted into percent disease index (PDI) using the formula

Sum of individual disease rating

$$PDI = \frac{\text{Total No. of x Maximum}}{\text{plants observed disease rating}} \times 100$$

(McKinney's Index)

The severity per plant was determined by calculating the average severity of the three canopies.

Table 1. Soybean rust severity assessment scale (Miles *et al* 2005).

Severity	% area of infected leaf	No of lesions
1	0	0
2	0.10 - 0.25	1-30
3	0.26 - 0.50	31-75
4	0.51 – 1.0	76-750
5	1.1 – 2.5	151-300
6	0.26 -0.50	301 -750
7	0.51 – 10.0	751- 1500
8	10.1 -20.0	1501-3000
9	>20	> 3000

Data analysis

Data on disease severity were subjected to analysis of variance using XLSTAT statistical analysis program. The mean PDI were compared at P= 0.05.

Results and discussion

Soybean plants infected with soybean rust were identified by observation of tan or reddish brown sporulating or none sporulating lesions on the underside of the leaves (Fig. 1). The results of the survey showed that rust was prevalent in all the districts surveyed with the PDI for all the farms was ranging from 40.37 to 74.81 (Fig. 2). This may be attributed to the close geographical location of the districts which makes it possible for the spores to be transmitted easily across the districts. Teso district which is at the boarder of Kenya and Uganda had the highest disease PDI recorded (74.81) the mean PDI in Teso was 60.39. The district with the least severity was Mumias district with mean PDI of 55.0. There was no significant difference in the severity level within the four districts (P= 0.088) (fig. 3). The high disease severity in western Kenya is attributed to the farmers choice of varieties soybean most farmers prefer Nyala and Gazelle varieties (Mahasi *et al*, 2009) despite the good attributes of the varieties they more susceptible to rust disease. High severity is also attributed to the ability of the fungal spores to survive in the environment for long.

The availability of alternative host like cowpea and other legumes plants grown alongside soybean has enable the spores to be dispersed further. High moisture and Temperatures between 15 and 28 C (~60-82F) are ideal for infection (Hartman *et al.* 1999). Kenya is located within the tropics and experiences tropical climate with high rainfalls between April and June that favors the growth and spread of the rust fungi.

(a) **(b)**

Fig. 1. *Phakopsora pachyrhizi* symptoms as observed on soybean leaves. (a) Sporulating lesions on the lower side of the leaves. (b) infected soybean leaves.

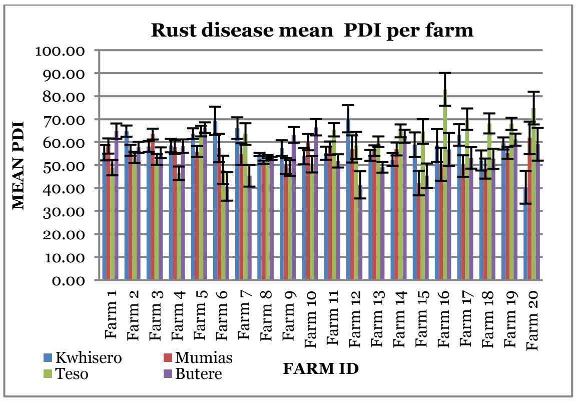

Fig. 2. Mean soybean rust disease severity per farm.

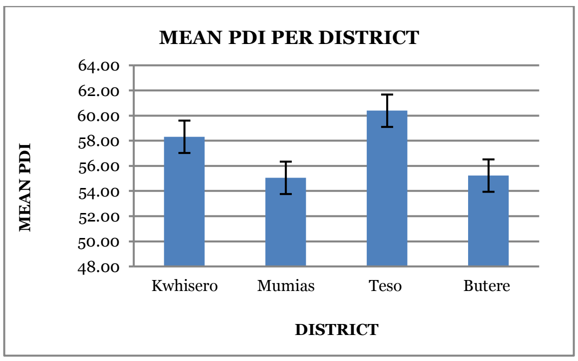

Fig. 3. Mean PDI per district P= 0.088.

In terms of control and management of soybean rust fungicide is the main control measure; this is mainly because of absence of rust resistant cultivars. The use of foliar fungicides to manage the disease in commercial plantings adds significantly to production costs (Miles *et al.*, 2003). The high cost of fungicides and lack of knowledge by farmers on the types of fungicides to use has also lead to increased severity of the disease.

Conclusion

The high severity rust disease in Western Kenya shows that adequate control measures have not been employed by to curb the rust disease. The results also implies that the rust population in this region is more virulent. The results of this study can be applied in other studies to determine the virulence of the rust fungi found in this region and to apply adequate control measures before the farms experience yield loss.

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