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Farmers' knowledge and perceptions of leaf spot disease of groundnut and its management in Northern Region of Ghana

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Groundnut (*Arachis hypogea* L.) is an important food source as well as cash crop for the people of Northern Ghana. The crop yield is low partly due to biological constraints which include diseases like leaf spot. A survey was conducted among 200 farmers in four districts of the Northern Region of Ghana, from June to August, 2014 using a structured questionnaire. The objectives of this study were to assess farmers' knowledge, perception and management of leaf spot disease of groundnut. Differences in farmer responses were evaluated using Chi-square test. A significantly higher (*P* =0.005) number of farmers (87.5 %) were aware of leaf spot disease of groundnut and could identify symptoms of the disease, but could not differentiate symptoms from herbicide injury. Majority (84.5 %) of the farmers reported the incidence of leaf spot disease on their farms to be 50 % and above. Most farmers (74.5 %) also reported the disease severity to be above 50 %. Male farmers (33.5 %) who used defoliation or brown spots as signs of maturity of the groundnut crop were significantly more (*P* =0.031) than their female counterparts (26 %). Farmers who used non-chemical methods (62 %) of managing leaf spot disease were significantly (*P* <0.001) higher than those who used recommended methods including the use of chemicals (38 %). It is important to educate farmers to enhance their capabilities for leaf spot disease management through farmers' field days. Also, since most of them use traditional methods such as crop rotation, appropriate spacing and mixed cropping as means of controlling the disease, and the use of effective plant extracts as an integrated management strategy would be ideal.

Key words: Leaf spots, knowledge, perception, management, Northern region.

INTRODUCTION

Groundnut is one of the most popular and widely cultivated legumes in Ghana because of its adaptation to a wide range of climatic conditions (Kombiok et al., 2012). In 2011, Ghana was ranked 10th in production

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volume (530,887 MT of in-shell groundnuts) in the world and 4th in Africa, after Nigeria, Senegal and Sudan (Ibrahim et al., 2012). It is an important cash crop in subsistence and commercial farming systems, as well as an important food source for the people in Northern region of Ghana (Tsigbey et al., 2003; Izge et al., 2007). Also, being a legume crop, groundnut helps in improving soil health and fertility by fixing N_2 and organic matter in the soil (Janila et al., 2013). It is estimated that 90% of farm families that cultivate groundnut as cash crop in Northern region of Ghana, rely on farming tools and technologies that can be characterised as indigenous, traditional and informal (Tsigbey et al., 2003; Pazderka and Emmott, 2010). Therefore, understanding agricultural knowledge structure, operations and challenges faced by rural farmers is critical because their livelihood depends substantially on their ability to make accurate agronomic assessment (Adam et al., 2015).

According to Hewitt (2000), about 10 to 20% of staple foods and cash crops are destroyed by diseases. One of such disease is leaf spot of groundnut which can cause yield losses of 50 to 70% in West Africa and up to 50% worldwide as reported by Tshilenge-Lukanda et al. (2012). In Northern region of Ghana, pod losses and defoliation due to leaf spot can reach 78 and 80% respectively (Tsigbey et al., 2001; Tsigbey et al., 2003). Leaf spot diseases are widely distributed and occur in epidemic proportions in northern region (Nutsugah et al., 2007). Thus understanding farmers' knowledge related to perceptions of crop diseases and their management practices is essential for the development of management strategies which have a high probability of being adopted by the intended users (Adam et al., 2015).

Studies have shown that most groundnut farmers often see defoliation as a sign of the crop maturity (Nutsugah et al., 2007). Many attempts have been made to develop groundnut cultivars that are resistant to leaf spot. Although researchers have developed and disseminated improved groundnut varieties to farmers, 50% of farmers in the region still cultivate and produce highly susceptible cultivars such as 'Chinese' (Ibrahim et al., 2012).

Leaf spot disease of groundnut is endemic in Northern region of Ghana because farmers rarely use fungicides to control diseases on their farms (Tsigbey et al., 2003; Nutsugah et al., 2007). Some farmers practice crop rotation, burning and burying of crop residues after harvest, removal of volunteer groundnuts and deep turning of crop debris which are seldom applied by smallholder farmers for reasons (Wilber, 2014) such as inadequate land size, lack of information especially in carrying out crop rotation and labour intensiveness (Tsigbey et al., 2003).

Consequently, control measures for pests and diseases would be more robust when more farmers' knowledge, perception and practices are taken into consideration (Heong et al., 2002. There has been increasing interest in incorporating farmers' indigenous knowledge into research and development programmes for finding workable solutions to agricultural problems (Isin and Yildirim, 2007; Obopile et al., 2008).

Despite the established critical role of farmers' knowledge in the control and mitigation of pests and diseases, very few studies have focused on this subject in the area. Secondly, farmers' knowledge and practices of controlling leaf spot of groundnut varies in different parts of the world or even in different locations within a given country due to differences in agro-ecological and socio-economic setting under which production occurs. Thus, this study sought to contribute towards filling this knowledge gap by assessing farmers' knowledge and management practices for the control of leaf spot of groundnut in Northern region of Ghana. The objectives of this study sought to;

1. Assess farmers' knowledge, perception and management of leaf spot disease of groundnut.
2. Determine the incidence and severity of leaf spot disease of groundnut on farmers' farms.

MATERIALS AND METHODS

Study area

The farm survey was conducted in communities within the Tamale Metropolis, Kumbungu, Tolon and East Gonja districts in the Northern Region of Ghana during the 2014 cropping season (Figure 1). Northern region of Ghana is located on latitude 9° 29' 59.99"N and longitude 1° 00' 0.00"W (Anonymous, 2017). It occupies a land area of about 70,384 km^2, which is approximately 30% of the total land area of Ghana. The region is bounded by Brong-Ahafo and Volta regions to the south, the Upper West and Upper East regions to the north, the Republic of Togo to the east and the Republic of La Cote d'Ivoire to the west (Badii et al., 2012).

Survey on farmers' knowledge, perception and management of leaf spot disease

The survey was conducted by administering questionnaire to groundnut farmers in four administrative districts of the Northern region of Ghana, namely Tamale Metropolis, East Gonja, Tolon and Kumbungu (Figure 1). The districts were purposively selected based on the operational areas of the Presbyterian Agricultural Station-Mile 7 (PAS-Mile 7) which is promoting the production and marketing of groundnut among smallholder farmers. A multiple-stage sampling technique was used to select the respondents for the study. First, a total of 20 communities, consisting of five from each district were randomly selected through the assistance of field staff from PAS-Mile 7. In the second stage, using the list of farmers in the institution as the sampling frame, ten farmers were randomly selected from each community, which resulted in a total of 200 respondents.

A semi-structured questionnaire designed in a closed- and open-ended manner was used to elicit information on farmers' knowledge, perception and management of leaf spot disease based on preliminary surveys and extension experience with farmers. The questions were developed on the following key aspects: farmer's demographic information, knowledge of leaf spot disease and management strategies. A pilot test was conducted with 30 groundnut farmers in two communities which were not included in

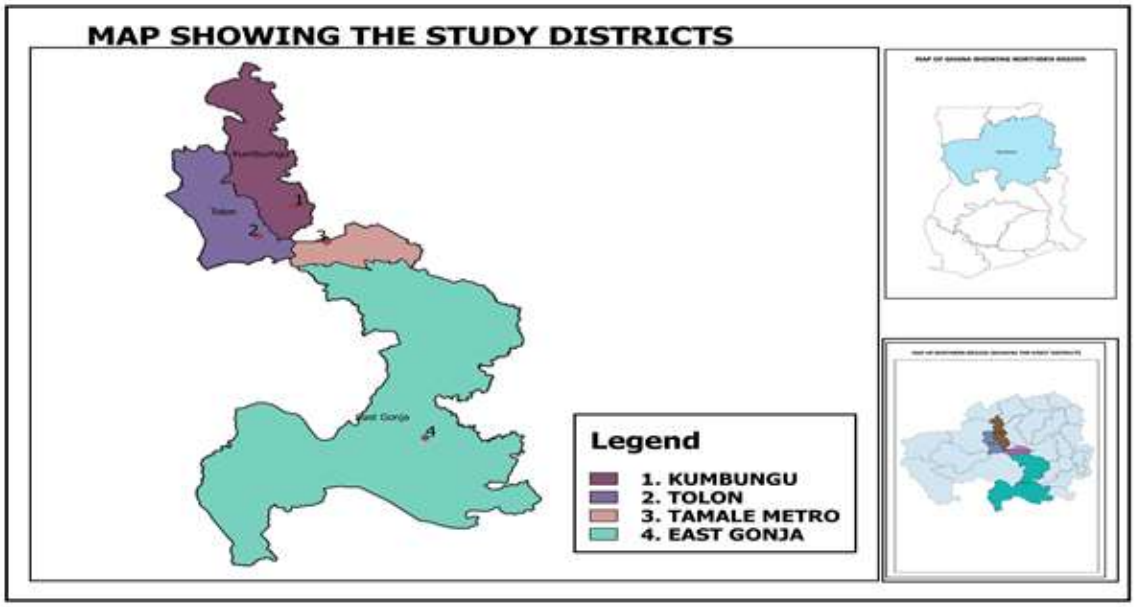

Figure 1. Map showing the study districts in Northern Region of Ghana.

Table 1. Florida 1 to 10 scale system for groundnut.

Scale	Interpretation
1	No leaf spot
2	Very few lesions on the leaves, none on the upper canopy
3	Few lesions on the leaves, very few on the upper canopy
4	Some lesions with more on the upper canopy, 5% defoliation
5	Lesions noticeable even on upper canopy, 20% defoliation
6	Lesions numerous and very evident on upper canopy, 50% defoliation
7	Lesions numerous on upper canopy, 75% defoliation
8	Upper canopy covered with lesions, 90% defoliation
9	Very few leaves remaining and those covered with lesions, 98% defoliation; and
10	Plants completely defoliated and killed by leaf spot

Source: Chiteka et al. (1988)

the sample, a month before the study. After the pilot test, minor changes were made in the questionnaire to enhance clarity.

Data were collected using face-to-face interview combined with farm observations, from June to August, 2014. The survey was conducted by field staff PAS -'Mile 7'. Each interview lasted for about 30 minutes. Dagbani which is mostly spoken by the farmers was used throughout the interactions with respondents. A total of 200 farmers were used in the analysis; consisting of 100 female farmers and 100 male farmers.

Determination of the incidence and severity of leaf spot

A total of 40 farmers, 10 from each of the four districts were selected using a multi-stage sampling technique. Farms were then examined to determine the incidence and severity of leaf spot. Assessment of disease incidence was done by walking diagonally across the farm and scoring groundnut plants for the presence or absence of leaf spot symptoms. Samples of leaves were also collected at every tenth pace along the diagonal walk. These leaves were used to assess severity of leaf spot using Florida scale of 1 – 10, where 1= no leaf spot and 10= plants completely defoliated and killed by leaf spots. The descriptive keys were used to determine the severity of the disease (Table 1).

Data analysis

The Statistical Package for Social Scientists (SPSS) version 16 was used to analyse the association of the responses between male and female by employing the Chi-Square test. The non-parametric Kruskal-Wallis equality-of-populations rank statistical test was employed to determine whether disease severity measured on an ordinal scale, differed based on farms.

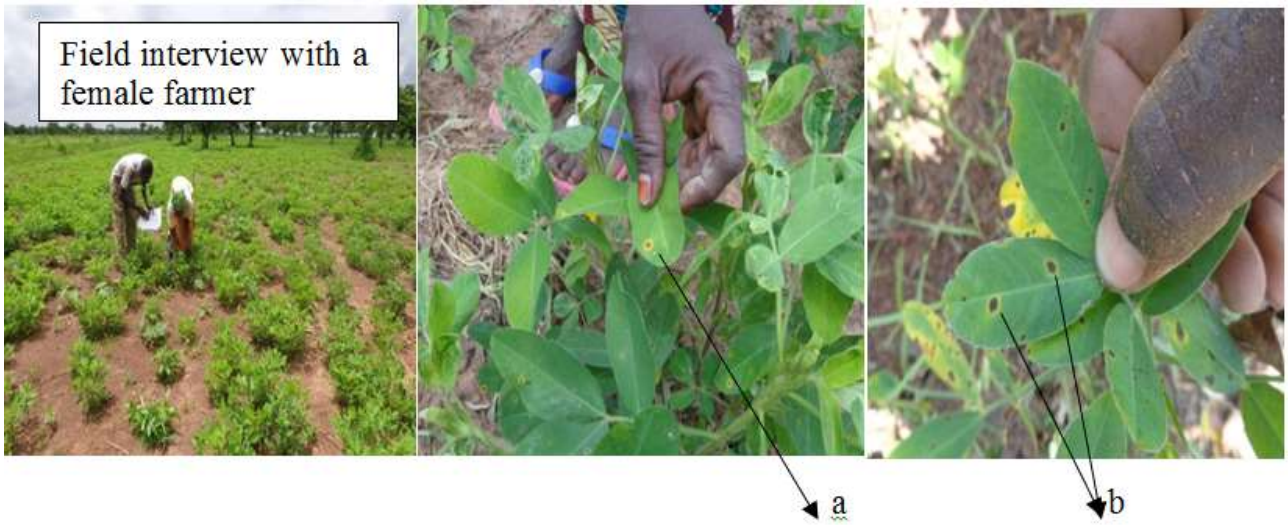

Figure 2. A Female farmer (a) and male farmer (b) in East Gonja identifying leaf spot on their farms.

RESULTS

Determining farmers' knowledge and perception of leaf spot diseases of groundnut

A significantly higher (P =0.005) number of farmers (87.5%) were aware of leaf spot disease of groundnut. 47% of farmers who affirmed their awareness of the disease were males whilst the rest (40.5%) were females. Among farmers who had not heard of the disease, 3% were males whilst 9.5% were females.

Majority (84.5%) of the farmers knew the symptoms of the disease. The rest (15.5%) were ignorant. A significantly higher (P = 0.032) percentage of male farmers (45%) knew of the symptoms of the disease. Most of the farmers (84.5%) who claimed to know the disease could identify the symptoms of the disease on their groundnut farms. More male farmers (45%) could identify the leaf spot disease symptoms than their female counterparts (39.5%). All the farmers who claimed that they knew the symptoms of leaf spot could actually identify them on their farms (Figure 2). Although more male farmers (40.5%) could identify the disease symptoms than the females (38.5%) the difference was not significant (P > 0.05).

Most farmers (91%) attributed the cause of the disease to poor soil fertility, high rainfall, wind or air and herbicides application while the rest (9%) attributed it to insects and drought. A significantly higher (P = 0.048) percentage of male farmers (47.5%) attributed the cause of the disease to poor soil fertility, high rainfall, wind or air and herbicides application. None of the farmers attributed the disease to pathogens. Majority (84.5%) of the farmers reported leaf spot disease incidence in their farms to be 50% and above whilst the rest (15.5 %) reported the disease incidence to be 20 to 49%.

Female farmers recorded a significantly (P = 0.003) higher disease incidence than their male counterparts (Table 2). A significant percentage of farmers (61%) observed the appearance of the disease from 1 to 3 weeks after planting (WAP) whilst the rest (39%) observed it at 4 WAP. A significantly higher percentage of females farmers (34.5%) claimed that they observed the disease earlier (that is, 1 to 3 WAP).

Farmers also reported that the disease was encountered any time they cultivate groundnut. There was no significant (P > 0.05) difference among farmers who encountered the disease every season or every year. Most of the farmers (74.5%) reported the disease severity to be above 50% whilst the rest (25.5 %) described the disease severity to be less than 50%.

Generally, female farmers (32%) experienced significantly (P < 0.001) lower disease severity compared to male farmers (42.5%). During the farm survey, it was observed that farms belonging to women were either an acre or less, free from weeds and intercropped mostly with vegetables. However, farms of male farmers were mostly more than an acre, weedy and sole cropped. Some women farmers also reported that, they sprayed aqueous neem leaf or seed extracts on their plants to prevent pest and disease from attacking their crops. All of the farmers could determine when their groundnut crops reached maturity and were ready for harvest.

Farmers who used defoliation or brown spots of the groundnut crop to determine its maturity were significantly more (P = 0.031) compared to those who used sample digging. Male farmers (33.5 %) who used defoliation or brown spots as a sign of maturity were significantly more (P = 0.031) than their female counterparts (26%) (Table 2).

Table 2. Farmers' knowledge and perception on the existence of leaf spot of groundnut.

Factor	Farmer responses	Sex of respondents			Chi-square	*P*-value
		Male (%)	Female (%)	Total		
Whether farmer has heard of leaf spot disease before	Yes	47	40.5	87.5	7.726	0.005
	No	3	9.5	12.5		
Whether farmer is aware of the disease symptoms	Yes	45	39.5	84.5	4.619	0.032
	No	5	10.5	15.5		
Whether farmer can identify diseased samples or examples	Yes	45	39.5	84.5	4.619	0.032
	No	5	10.5	15.5		
If yes, on which plant part do you observe the disease	Whole plant with symptoms	9.5	11.5	21	0.482	0.487
	Leaves with symptoms	40.5	38.5	79		
Farmer's believe of the cause of leaf spot.	Low soil fertility, high rainfall, wind /air and herbicides	47.5	43.5	91	3.907	0.048
	Insects and drought	2.5	6.5	9		
Farmer's description of the incidence of the disease in his/her farm	Low (20-49 %)	11.5	4	15.5	8.589	0.003
	High (50 % and above)	38.5	46	84.5		
What time and stage of growth farmer encounters the disease	1-3 weeks after planting	26.5	34.5	61	5.380	0.020
	4 weeks and above	23.5	15.5	39		
How often farmer encounter the disease	Every season	42.5	41	83.5	0.327	0.568
	Every year	7.5	9	16.5		
Whether farmer is aware of the effects of the disease on yield	Yes	40.5	43	83.5	0.907	0.341
	No	9.5	7	16.5		
Farmer estimates on the severity of the disease on a scale of 5	Not severe (1-3)	18	7.5	25.5	11.607	0.001
	Very severe (4-5)	42.5	32	74.5		
How farmer determines the maturity of groundnut	Leaf defoliation and brown spots	33.5	26	59.5	4.669	0.031
	Sample digging	16.5	24	40.5		

Disease management practices

Farmers who used their own methods (62%) of managing leaf spot disease were significantly more (P <0.001) than those who used recommended methods including the use of chemicals (38%) (Table 3). Other management strategies proposed by farmers were improved research, fertilizer/manure application, spraying with recommended fungicides / plant extracts and reporting the disease situation to Ministry of Food and Agriculture (MoFA).

Incidence and severity of leaf spot

Leaf spot disease incidence or prevalence was 100 % on the farms surveyed. Based on the Kruskal-Wallis equality-of-populations rank test (as shown in Table 4), the rank sum of disease severity for farmers in East

Table 3. Farmers disease management practices on groundnut farms.

Factor	Farmer responses	Sex of respondents			Chi-square	*P*-value
		Male (%)	Female (%)	Total		
Farmers' management practices on the disease	Non-chemical methods	38	24	62	16.638	<0.001
	Recommended methods including chemicals	12	26	38		
Other ways forward to minimizing leaf spot disease as proposed by farmers	Improved research, Spray with plant extracts / fungicides	29.5	32	61.5	0.528	0.467
	Fertilizer/Manure Application and reports to MoFA	20.5	18	38.5		

Table 4. The results from Kruskal-Wallis equality-of-populations rank test.

Community name	Observation	Rank sum
Tamale metropolis	50	5727
East Gonja	50	8244
Tolon	50	4023
Kumbungu	50	2106
Chi-squared with ties	122.008 with 3 d.f. ; probability=0.0001	

Gonja Municipality (8244) was the highest, followed by Tamale Metropolis (5727) and then Kumbungu district (2106).

DISCUSSION

Farmers' knowledge and perception of leaf spot disease of groundnut

Majority (87.5%) of the groundnut farmers in the study area knew that leaf spot is a disease. This means that more farmers are aware of the disease in their farms and its devastating effects. More males (47%) were aware of the disease than females (40.5%). This may be attributed to the fact that males are more involved in farming than females in Northern region of Ghana. The greater awareness could be due to their role as family heads who are mostly in charge of farming. It could also be that males are more resourced than females and have easy access to information on agronomic practices, pest and disease management. This confirms the report by Quisumbing et al. (1995), that although they provide 60 to 90% of the farm work as females, they usually lack technical knowledge, and often have poor access to current information, markets and credit to enable them engage in cash crop farming.

Majority of the respondents (84.5%) knew the symptoms of the leaf spot disease. This means that more farmers could identify the symptoms of the disease. The findings in this study confirm an earlier report that traditional rural farmers are able to successfully detect plant diseases through observation informed by their farming experiences in the absence of a scientific process and equipment to conduct such assessment (Adam et al., 2015). Most of the farmers (79%) were able to identify the symptoms on the leaves of groundnuts on their farms. This clearly indicates that farmers in the Northern region of Ghana have observed the disease for a very long time. It also shows that the disease is common in all groundnut growing areas and also commonly found on the leaves of the crop. The report that the leaf spot disease is commonly found wherever groundnut is grown is true (Zhang et al., 2001; Nutsugah et al., 2007; Chaube and Pundhir, 2009).

Majority (91%) of the smallholder farmers attributed the disease to poor soil fertility, high rainfall, wind or air and herbicides applications. This implies that farmers have critically observed the disease for a very long time in order to determine the factors that cause or increase the incidence and severity of the disease. However, it also shows that farmers may not be able to distinguish between herbicides injury to groundnut plants and leaf spot disease. Herbicides injury to plants is normally due to wrong time of application, wrong dosage and application under unfavourable environmental conditions.

Farmers in the Northern Region of Ghana (84.5%) rated leaf spot disease incidence on their farms to be

50% and above which confirms an earlier report that both early and late leaf spots diseases are widely distributed and occur in epidemic proportions in Northern region of Ghana (Nutsugah et al., 2007). Female farmers recorded higher percentage of disease incidence than male farmers. This can be attributed to the fact that most women are restricted to continuous cultivation on marginal lands and old groundnut farms where there is a build-up of inoculum and loss of nutrients. This supports report of Pazderka and Emmott (2010) that factors that limit yields of groundnut in Ghana include increased cultivation on marginal lands and outburst of pest and diseases. Female farmers also reported that the disease is often encountered at the early stage of vegetative growth which probably is an indication of early leaf spot.

Most farmers (83.5%) in the Northern region of Ghana encountered this disease, any season groundnut was planted and they were aware of its detrimental effects leading to significant yield losses. This agrees with the report that leaf spot is widely spread and causes pod loses of about 78% in Northern region of Ghana (Tsigbey et al., 2003; Nutsugah et al., 2007).

Farmers observed highly significant disease severity on their farms. Even though female farmers experience higher (46%) incidence of the disease their farms had a lower disease severity (32%) than those of the males. It implies that female farmers practiced better crop management than their male counterparts. Good crop management strategies can help reduce the severity of a disease. Most of the farmers (60%) used defoliation and brown spots to determine the maturity of the groundnut crop which confirms reports that farmers use the defoliation as a sign of groundnut maturity (Tsigbey et al., 2003; Nutsugah et al., 2007).

Leaf Spot disease management

More farmers (62%) relied solely on non-chemical methods for the control of the disease. This confirms the report of Bently and Thiel (1999) that farmers in developing countries have been using their own knowledge in managing plant diseases. Most of the non-chemical methods mentioned were crop rotation, spacing, and mixed cropping among others. Farmers reported that more research should be carried out on other control measures to help reduce the negative impact of this disease. This is an indication that most of the measures are old and do not help much in reducing the disease incidence and severity on their groundnut farms.

Incidence and severity of leaf spot on selected farms

Leaf spot was prevalent in all farms surveyed. There were significant differences ($P<0.05$) in disease severity among farms. Disease severity was highest in East Gonja (8244) followed by Tamale Metropolis (5727) and Tolon (4023). Farmers in Kumbungu (2106) experienced the lowest disease severity. This is an indication that the levels of severity differ from locality to locality, district to district and ecology to ecology due to differences in environmental conditions as reported by Nutsugah et al. (2007).

Conclusion

The study revealed that farmers were aware of the leaf spot disease and its devastating effects, and perceives it as a major constraint to groundnut production in Northern region of Ghana. Most farmers (84.5%) in the study area rated leaf spot disease incidence on the farm to be 50% and above. A notable finding from this study is that farmers may not be able to distinguish between herbicide injuries to plants and leaf spots. Farmers also expressed various opinions as the future management strategies for lessening leaf spot problem in the area which included spraying with effective plant extracts. Farmers in Northern region of Ghana rely solely on non-chemical methods for minimizing the effects of leaf spot disease. The study showed that leaf spots severity differ from one locality to another depending on environmental factors and control measures adopted by farmers. Farmers need to be educated on the practices that increase incidence and severity of the disease, how to distinguish the symptoms from herbicides injury and integrated management approach which may include the use of plant extracts since the disease is widely distributed and endemic in the study area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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