

# Survey of Chickpea (*Cicer arietinum* L) Ascochyta Blight (*Ascochyta rabiei* Pass.) Disease Status in Production Regions of Ethiopia

Megersa Tadesse<sup>1,\*</sup>, Losenge Turoop<sup>1</sup>, Chris O. Ojiewo<sup>2</sup>

<sup>1</sup>Research Methods Program, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya

<sup>2</sup>International Crops Research Institute for Semi-Arid Tropics, Addis Ababa, Ethiopia

## Email address:

magetade@gmail.com (M. Tadesse)

\*Corresponding author

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**Abstract:** Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in Ethiopia. Earlier reports and field observations have shown that Ascochyta blight caused by *Ascochyta rabiei* is one of the most devastating diseases of this crop in Ethiopia. Survey was conducted during August 2015 to February 2016 to determine the status of the blight disease in major chickpea the growing area of Ethiopia. A total of 251 on-station and on-farm fields were surveyed. Ascochyta blight was observed in 30 of the 251 fields and incidence ranged from 0 to 45.6 % with mean of < 10%. The highest mean incidence was observed in Ensaro district of Amhara region (46.6%) followed by Lume district of Oromia region (15%). The severity varied from 1 to 7 with mean severity of 1 to 3.2 which was observed in few fields. The low incidence and severity of the disease observed in the 2015/2016 season was associated with the drought conditions occasioned by *El nino* conditions.

**Keywords:** Ascochyta Blight, Chickpea, Drought, Prevalence, Incidence, Severity

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## 1. Introduction

Chickpea is legume crop in reducing poverty and hunger, improving human health and nutrition, improving incomes especially to smallholder women farmers and enhancing ecosystem balance. The crop is grown in more than 50 countries and is third in production after dry bean and field pea (FAOSTAT, 2014). Africa accounts for 5% of world's chickpea production, mostly from Ethiopia, Malawi, Tanzania and Kenya in Eastern Africa and Morocco in North Africa. Ethiopia is among the top five world producers of chickpea (FAO, 2014). Ethiopia is the largest producer of chickpea in Africa, accounting for about 60% of the continent's production in 2014.

Despite its importance in Ethiopia, its productivity (1.9 tons ha<sup>-1</sup>; CSA, 2015) is still relatively low compared to its potential under well managed production (5 tons ha<sup>-1</sup>). Although many factors contribute towards low chickpea production, blight disease caused by *Ascochyta rabiei* (Pass.) Lab. is one of the major limiting factors. This disease has

been reported in Ethiopia as well as in 35 countries across six continents (Pande et al., 2005; Nene et al., 1996).

Ascochyta blight causes death to plant, reduces seed quality and causes yield losses up to 100% (Haware, 1998; Nene et al., 1996; Pande et al., 2005; Pande et al., 2011; Knights and Siddique, 2002; Merzoug et al., 2009; PRRP, 2008 and Chongo et al., 2000). It is usually associated with severe reduction in chickpea yield and quality, especially under cool and wet conditions (Kaiser 1997). Blight disease can infect all above-ground plant parts.

Ascochyta blight problem in Ethiopia has been aggravated by changes in chickpea production and rainfall patterns (Abate et al., 2011). Continuous rainfall and cloudy weather conditions during growing season enhance the development and spread of the disease (Jhorar et al., 1998). The disease occurs at all physiological stages ranging from seedling to maturity (Singh and Sharma, 1998). Other climatic factors such as temperature, relative humidity, wetness duration and windiness favor the occurrence and spread of the disease (Weltzein and Kaak, 1984; Trapero-Casas and Kaiser, 1992;

Reddy and Singh, 1990). Therefore, timely measures at all growth stages should be taken to prevent chickpea from Ascochyta blight. Farmers in Ethiopia try to get over it by planting late when the rains have subsided, but end up with the challenge of terminal drought.

Development of effective disease management strategy depends, among others, on the timely detection and precise identification of the pathogen and timely application of the control measures. Survey and identification of plant pathogens is important to understand the association of pathogens with a specific host plant and to map out their geographic distribution (Agrios, 1997). In Ethiopia, despite the importance, the blight disease has not been extensively studied and there is no current quantitative information on the status of blight foliar disease on chickpea production. Therefore, the main objective of this study was to determine chickpea ascochyta blight status in the chickpea production regions of Ethiopia.

Ascochyta blight epidemics are a recurrent phenomenon in Ethiopia (Asrat *et al.*, 2015), indicating that no cultivars are immune to *A. rabiei* as the pathogen continues to evolve the ability to overcome resistant varieties (Chen *et al.*, 2004). More effort is needed to identify new sources of resistance. Knowledge of genetic variation of pathogen populations is required for successful resistance breeding (Peever *et al.*, 2004). However, recent observations indicate that the disease occurrence is becoming variable over seasons due to changes in precipitation that favour disease development and severe pod infection (Abang and Malhotra, 2008). Considering that even resistant chickpea varieties are susceptible to Ascochyta blight during the reproductive phase, concerted effort is needed to ensure the development of lines that are resistant at all developmental stages of the crop (Abang and Malhotra, 2008).

## 2. Materials and Methods

### *Disease Survey and Sampling*

Field surveys were conducted between August 2015 to February 2016 during the chickpea growing season in four major regions (Oromia, Ahmara, SPNNP and Tigray) of Ethiopia for the determination of the prevalence, incidence, and severity of chickpea blight disease. Emphasis was put on areas where chickpea is an important crop, or areas known to be hot spots of the disease. Fields sampled were 5 to 10 km apart. A total of 251 fields covering 83 districts were surveyed from both farmers' and experimental fields based on reports received from farmers, local extension agents and collaborative research centers on disease occurrence. In each location, crop condition, growth stage, disease symptoms, and aphid populations was recorded on 10 to 20 plants selected at random while walking in a diagonal path. Infected chickpea plant samples (leaves, stems and pods) were placed in labeled plastic bags and were taken to the EIAR laboratory for isolation and further analysis.

Geographic features like latitude, longitude and altitude were recorded from all surveyed areas using handheld Global

Positioning System (GPS), to trace back the specific locations and symptoms of blight fungi. Percent of disease prevalence, incidence and severity (1–9 rating scale; 1= No visible symptoms; 2= minute lesions prominent on the apical stems; 3= lesions up to 5–10 mm in size and slight drooping of apical stems; 4= lesions obvious on all plant parts and clear drooping of apical stems; 5= lesions on all plants parts, defoliation initiated, breaking and drying of branches slight to moderate; 6= lesions as in 5, defoliation, broken, dry branches common, some plants killed; 7= Lesions as in 5, defoliation, broken, dry branches very common, up to 25% of plants killed; 8= symptoms as in 7 but up to 50% of the plants killed; 9= Symptoms as in 7 but up to 100% of the plants killed (Jan and Wiese 1991; Chen and Muehlbauer 2003; Chen *et al.*, 2004; Sharma *et al.*, 2005 and Pande *et al.*, 2011) were recorded for each field. Disease prevalence was determined by ratio of number of locations showing chickpea disease to total number of locations/fields. Field incidence of each field was calculated by totaling the number of plants with symptoms and converting to percent. The severity rating represents an average severity for the plants examined in each field.

Data collected from the survey was coded and checked for consistence and completeness and analyzed using R statistical procedures. Descriptive statistics were used to summarize the data. Analysis was conducted by disaggregating important relevant information by district and region so that comparison could be made.

## 3. Results and Discussion

Field surveys generate knowledge on the current status of Ascochyta blight disease prevalence, incidence and severity, which forms the basis of priority setting in the integrated disease management. Such knowledge is currently lacking or outdated for chickpea Ascochyta blight pathosystem in Ethiopia and should be updated annually. Ascochyta blight is a serious disease, which is mostly prevalent in cool humid weather conditions. Although the disease is prevalent in Ethiopia, reports on its incidence and severity are scanty. In the present survey, the estimate disease status of four regions were made according to disease prevalence, incidence and severity of chickpea blight.

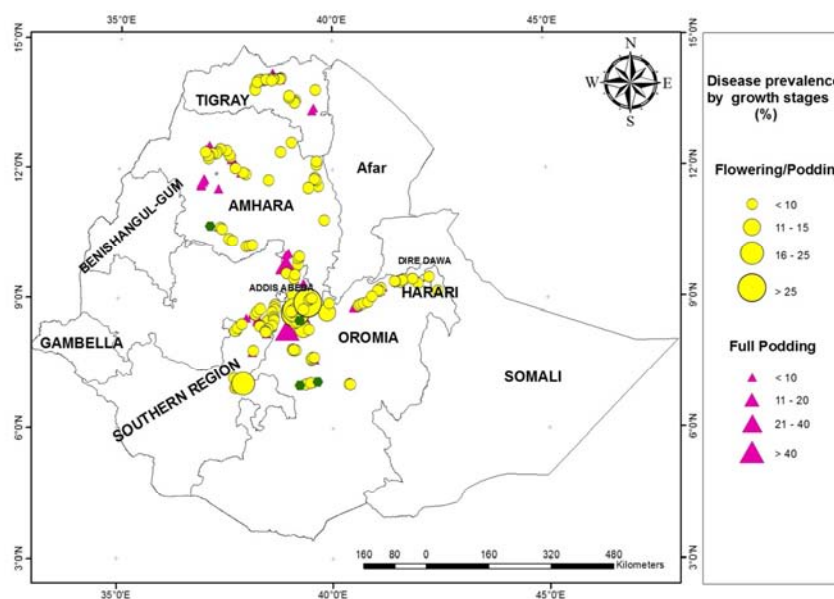
Disease symptoms were observed early in October in few fields. Hot and dry weather associated with the 2015/2016 *El nino* arrested disease progress in all regions. Similar results have been reported (Ahmed *et al.*, 2008). Ascochyta blight is epidemic (Ahmed *et al.*, 2005; Chang *et al.*, 2000, 2003) in the surveyed area, and disease prevalence and severity depends on weather conditions, including precipitation (Chang *et al.*, 2000, 2003), particularly relative humidity (Trapero-Casas and Kaiser, 1992). Cloudiness and prolonged wet weather favour rapid development and spread of the disease. The results of this study demonstrate very low distribution of the disease in almost all chickpea growing areas limited by blight-unfavoured weather conditions of this season as compared to observations in earlier seasons. The

results obtained in this study are similar to those reported by Chongo et al. (2002), Gurjar et al. (2010), Pande et al. (2012), Nene et al. (2012) and Ali and Ozkan (2015).

Several symptoms were found on chickpea during the surveys, which included lesions, wilt, foliar yellowing and yellow stunt. These symptoms were discernible in the early stages of development but later they became difficult to distinguish. Lesions started occurring at vegetative stages but later it became difficult to distinguish from moisture stress or nutrient deficiency. *Ascochyta rabiei* attacked the aerial parts of chickpea plant; on leaflets the lesions were either round or elongated, bearing irregularly depressed brown dots surrounded by a brownish red margin. On the green pods, the lesions were circular with dark margins with pycnidia arranged in concentric circles. The infected seeds had the lesions too. Elongated, brown lesions were also observed on the stem and petiole, which bore black dots that girdled the affected portion. Where lesions girdled the stem, the portion above the point of attack rapidly died. Where the main stem was girdled at the collar region, the whole plant died. In the fields where the disease had advanced, patches of diseased plants were prominent in the field and slowly spread,

involving the entire field. Symptoms started occurring at vegetative stage and the spread was high at flowering and pod setting stages, varying among few observed fields.

A total of 251 farms from 83 districts were surveyed keeping in view the disease severity, topography and environmental conditions of these areas. Levels of *Ascochyta* blight varied among crop districts, but the disease was absent in most districts, limiting interpretation of these differences. The prevalence of chickpea *ascochyta* blight in different areas are given in Table 1 and Figure 1. We note mean disease prevalence for the area surveyed ranged from 0 to 25 %. It is evident from the table that maximum prevalence (25%) was recorded in Debre Brihan area followed by East Shewa (15%). The prevalence of the disease in other surveyed areas varied from 0 to 10%. Most of the chickpea growing areas have not shown disease prevalence and this indicates that the weather condition of this year was not conducive for *ascochyta* blight development. In Debre Brihan zone, particularly in Ensaro district blight disease was moderately prevalent. The disease was more prevalent during flowering/pod setting stage in surveyed fields (Figure 3.1).



**Figure 1.** Prevalence of chickpea *ascochyta* blight disease by growth stages in major chickpea growing regions of Ethiopia (2015).

Most of this blight prevalence at flowering/pod setting was observed in Amhara region followed by Oromia region with <10% (Figure 3.1). From the survey, less disease prevalence was also observed during full podding (<10%) which varied across surveyed areas with the exception of a few fields which had >40% (Figure 3.1). The individual prevalence of chickpea blight in each area is given in Table 1. The 2015/16 growing season was extremely dry throughout most of chickpea growing areas of Ethiopia, resulting in negligible blight disease levels.

The mean disease incidence for area surveyed ranged from 0 to 45.6 % and that of average severity varied from 1 to 3.2. Moderate disease incidence was observed in Debre Brihan

(45.6%) area of Amhara region while low disease incidence was observed in East Shewa (15.5%), Wolaita (9.3%), North Shewa (5%), North Wollo (2.5%) and South Wollo (2.1%). Particularly, in Minjar district of North Shewa Zone, the blight disease was observed on research station with high incidence (82%). The maximum disease severity (3.2) was observed in East Shewa zone of Oromia region. No *ascochyta* blight was observed in the surveyed areas of Oromia region except East Shewa area. Most of the surveyed fields showed very low levels *Ascochyta* blight severity (mean < 2) (Table 1), likely due to the hot and dry weather condition. *Ascochyta* blight was not observed in Tigray region during the growing season of 2015/16. In the SNNP

region, ascochyta blight symptoms were observed only in one field around November, but the distribution was low. The same situation was reported in Canada (Chongo *et al.*, 2002). Besides the scanty rainfall, the temperature in all areas was

relatively high during survey period, thereby limiting the chances of blight occurrence in these areas (Table 2). The individual mean prevalence, incidence and severities of chickpea blight in each areas are given in Table 1.

**Table 1.** Prevalence, incidence, and severity of *Ascochyta* blight in major chickpea growing areas of Ethiopia (2015).

Region	Zone	No. of districts covered	No. of fields surveyed	Disease Prevalence (%)	Disease Incidence (%)		Disease Severity (1-9 rating)	
					Range	Mean	Range	Mean
Oromia	East Harage	4	13	0	0	0	1	1
	West Harage	3	15	0	0	0	1	1
	South West Shewa	9	28	0	0	0	1	1
	North Shewa	1	3	0	0	0	1	1
	Arsi	2	12	0	0	0	1	1
	Bale	3	8	0	0	0	1	1
Amhara	East shewa	7	39	15	0-84	15.5	1-7	3.2
	South Gonder	5	5	0	0	0	1	1
	North Gonder	4	15	0	0	0	1	1
	West Gonder	2	9	0	0	0	1	1
	East Gonder	2	6	0	0	0	1	1
	North Shewa	5	31	10	0-82	5	1-4	1.8
	North Wollo	7	9	8	0-15	2.5	1-3	1.6
	South Wollo	1	1	5	5-40	2.1	1-3	1.4
	Debre Brihan	2	6	25	5-86	45.6	2-5	2.3
	SNNP	3	6	0	0	0	1	1
Tigray	Gurage	1	2	0	0	0	1	1
	Hadiya	1	2	0	0	0	1	1
	Wolaita	2	8	5	56	9.3	1-6	2.0
	West Tigray	3	4	0	0	0	1	1
	Central Axum	3	10	0	0	0	1	1
	North West Tigray	5	12	0	0	0	1	1
	North Tigray	1	1	0	0	0	1	1
	East Tigray	3	3	0	0	0	1	1
	South Tigray	3	3	0	0	0	1	1

Drought was widespread in Ethiopia during 2015/16 growing season. Northern and central parts of Ethiopia received lower amounts of rain than other areas and this was not favourable to ascochyta blight development. Although infection started in some fields in some regions, further disease development was arrested due to drought conditions. Most fields that were surveyed between October and December were in Oromia and Amhara Region (Table 1). Even though symptoms of ascochyta blight started at vegetative stages in some fields, severity was generally low in these fields, ranging from 1 to 7 (Table 3.1). Two fields in East Shewa research sites had disease severities up to 9 on the scale used. Majority of fields had no disease. Moderate disease incidence observed in some districts was probably due to cool temperature and relatively high humidity conditions that are suitable for disease development (Pande *et*

*al.*, 2005) and conducive to the development of the sexual stage (Raheem *et al.*, 2008). Debre- Birhan is a highland area with higher altitude (2750 m.a.s.l) and high humidity (65.91%) (Table 2) which favoured development and spread of the pathogen in the area. Most other places were disease-free with generally low disease incidence throughout the country. This was most likely due to hot and dry weather conditions brought by *El Nino* drought of 2015. No Ascochyta blight infection was detected in 19 of 25 zones in 2015/2016. Without anticipation of the 2015/2016 drought, and in the usual bid to avoid the disease, most chickpea farmers planted late which also helped to limit disease occurrence and development. Similar results were reported by Atik *et al.* (2010); Chongo *et al.* (2002) and Ahmed *et al.* (2008) who found low severity in many fields due to drought conditions.

**Table 2.** Summary table showing location, altitude, latitude, longitude and climatic characteristics of the chickpea growing areas showed blight symptoms 2015/16 crop season.

Zone	No of fields	Altitude (m)	Latitude (N)	Longitude (E)	Rainfall (mm)	Relative humidity (%)	Maximum temp (°C)	Minimum temp (°C)
East Shewa	12	1763	8.68245	39.13644	74.94	57.37	31.6	5.5
Debre Birhan	6	2750	9.79380	38.91766	67.56	65.91	22.0	1.7
North Shewa	8	1785	8.90808	39.41695	67.57	57.74	20.9	3.4
North Wollo	2	2266	12.6256	39.03724	88.49	59.74	28.3	10.3
South Wollo	1	2316	10.8346	39.81012	55.84	71.97	28.5	9.8
Wolaita	1	1880	7.0400	37.9200	131.39	65.39	29.7	13.4

The survey revealed that disease incidence and severity were low but varied low from locality to locality due to hot and dry weather conditions. Similarly, Ahmed et al. (2008) has also reported existence of blight disease variation among surveyed areas of Alberta which was associated to dry conditions. The observed incidence and severity of the disease in surveyed areas may be associated with the presence of favorable environmental condition. Increase in humidity favors the distribution of the pathogen (Pande et al., 2005).

Climate data on temperature, rainfall and relative humidity were compiled monthly for 2014/15 and 2015/16 growing seasons (Table 3). Weather conditions for both years differed substantially. Mean temperatures of growing seasons was highest in 2015/16. Similarly, rainfall distribution was quite different in both years. Mean relative humidity for 2015/16

was 58.71%, which was 5.52% less than that of 2014/15. Unlike in 2015/16, the cropping season in 2014/2015 was more favourable for disease development, and infections were observed on several locations on both cultivated chickpea varieties and wild relatives. Symptoms on chickpea seedlings were reported around mid of September in 2014/2015 in central parts of Ethiopia, which was much earlier than in this 2015/16. The widespread occurrence and early appearance of ascochyta blight symptoms in previous year was attributed to cool and wet weather conditions favourable for pathogen spread and infection, to high levels of inoculum in chickpea- production areas, and to planting of infected seed. This finding is in agreement with that of Chang et al. (2003) who found widespread *Ascochyta* blight on chickpea.

**Table 3.** Monthly average rainfall, relative humidity, monthly maximum temperature and minimum temperature of 2014/15 and 2015/16 for chickpea growing areas in Ethiopia.

	Aug		Sept		Oct		Nov	
Parameter	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
Average Rainfall (mm)	257.10	200.34	140.52	119.06	89.95	67.64	36.76	30.67
Average Relative Humidity (%)	73.56	67.90	72.63	67.89	66.03	59.35	63.28	59.67
Maximum Temperature (°C)	28.30	31.00	28.40	29.50	28.40	30.70	29.40	30.00
Minimum Temperature (°C)	2.10	2.90	3.20	5.80	2.20	5.30	2.10	3.30
	Dec		Jan		Feb		Mean	
Parameter	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
Average Rainfall (mm)	12.88	13.87	6.46	1.96	20.17	4.18	85.6	62.5
Average Relative Humidity (%)	57.44	55.05	57.40	51.75	59.29	49.35	64.2	58.7
Maximum Temperature (°C)	29.30	29.70	29.90	31.00	31.30	32.00	29.2	31.5
Minimum Temperature (°C)	0.10	1.00	2.40	-0.20	4.10	5.20	2.3	3.3

Increasing climate variability with the change in climate is recognized unequivocally. With the changing climate patterns and cropping systems, host, pathogen and favourable environment interactions are leading to diseases epidemics in a range of crops. These three essential components are required simultaneously for a disease to occur. *Ascochyta* blight is thought to be largely influenced by microclimate of the crop which in turn is influenced by prevailing weather conditions. Climate variability is adding a new dimension to managing plant diseases by altering the equilibrium of host-pathogen interactions resulting in either increased epidemic outbreaks or new pathogens surfacing as threats or less known pathogens causing severe yield losses (Aggarwal, 2003). Climate variability has positive and negative impacts on host-pathogen interactions. However, climatic changes could result changes in diseases/pathogens (Pande and Sharma, 2010).

Associations of disease with El-Nino have been made and indicate the potential for future epidemics if weather patterns become more variable (Checkley et al., 2000; Rodó et al., 2002). Plant pathogens have varying ranges of temperature requirements that affect the various steps in disease infection

cycles such as penetration, pathogen survival, dispersal, epidemic development, survival and sexual reproduction. Cooler temperature and wetter conditions are associated with increased incidence on blights in chickpea (Pande et al., 2010; Panagga et al., 2004).

Microclimatic factors such as plant temperature, relative humidity, rainfall, moisture, surface wetness and light interception can affect the sporulation of fungi. Any alteration in these factors would retard AB development. Rainfall and high relative humidity (> 95%) are critical for most epiphytotics, with temperature also playing an important role in development (Shtienberg et al., 2000). When the temperature is favourable and the moisture requirements of a pathogen on a susceptible host are fully met, an epidemic is likely to develop (Jhorar et al., 1998; Pande et al., 2005) which was observed during this survey. Under favorable conditions such as cool and moist weather (>350 mm annual rainfall, 23–25) °C temperature and > 95% relative humidity) the disease may cause 100% yield loss (Hassani, 1981; Nene and Reddy, 1987).

Rainfall has influence on epiphytotic and revealed that high rainfall resulted in high chickpea blight incidence. Ketelaer et

al. (1988) reported monthly rainfall of 40 mm were needed before an epidemic of AB occurred. Rain splashing may accelerate the disease spread and keep the leaf surface wet. Increasing leaf wetness periods increase the disease severity (Armstrong *et al.*, 2004). Relative humidity directly influences sporulation by many fungi and has implication for the persistence of wetness. Temperature has important effects on the lifecycle of *Ascochyta rabiei*, the infection process, and disease development. Ascochyta blight infection and disease development occur in the temperature range of 5 - 30°C, with an ideal temperature of 20°C (Trapero-Casas and Kaiser, 2007). Disease severity increased with increasing temperatures to a maximum of 20°C, then declined sharply at temperatures above 25-30°C. The present finding showed that ascochyta blight occurrence in 2014/15 was relatively higher than in 2015/16. The temperature and rainfall variability within the rainfed ecologies is very high, leading to varying intensities of moisture deficit in the country.

## 4. Conclusion

Chickpea is affected by a host of different pathogens despite its importance as the major pulse crop in Ethiopia. Ascochyta blight disease emerging as a potential threat to chickpea production. Basic information on the occurrences and geographic distribution of blight disease is very important for setting research priorities for further disease management strategies in different agro-ecologies. The distribution and incidence of ascochyta blight disease of chickpea varied in each region, but incidence and severity was generally low. Ethiopian agriculture is mostly rainfed, whereas inter-annual and seasonal rainfall variability is high and droughts are frequent in many parts of the country. High incidence in some locations, such as Debre Birhan and East Shewa are probably due to the presence of effective vectors and environmental conditions favouring their population buildup and movement. Depending on the environmental conditions and the availability of alternate hosts, the deleterious effect of blight can vary from season to season in the same area. There is likelihood that the status of these diseases can change to epidemic levels especially with climate change. A detailed analysis of the climatic factors responsible for absence of this disease needs further investigations. This information on ascochyta blight status will be helpful for growers for planning and administering blight management strategies to reduce the blight populations below their threshold levels.

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