

# A REVIEW OF SUSTAINABLE GRAY LEAF SPOT DISEASE MANAGEMENT OF QUALITY PROTEIN MAIZE (QPM) IN THE GUINEA SAVANNA ECOLOGIES OF TARABA STATE, NIGERIA.

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## ABSTRACT

The importance of Maize as daily staple food crop to almost every family in Nigeria and Africa can not be over – emphasized. QPM looks, tastes and yields like normal maize, but contains nearly twice the quantity of the essential amino acids, lysine and tryptophan, which are essential building blocks of protein in humans, and mono-gastric animals like poultry and pigs. It was reported elsewhere that susceptibility to major leaf diseases are the major weakness of International Maize and Wheat Improvement Center (CIMMYT) maize germplasm. Amongst the diseases Gray leaf spot, which has a very recent history of occurrence in Africa, is becoming the most important threat to maize production in the country. Yield losses ranging between 10% and 50% by gray leaf spot disease have been reported. *Cercospora zae-maydis* is a polycyclic, facultative pathogen favored by a high relative humidity (>95%), cool, cloudy conditions with an extended dew period and temperatures of 22-30°C. Due to polycyclic nature of the pathogen sustainable disease management strategies should gear towards: those which reduce the initial inoculum, reduce the spread of the pathogen and those which also reduce the duration of disease development within affected areas.

**Key words:** Gray leaf spot, Quality protein maize

## INTRODUCTION

In Nigeria, maize (*Zea mays* L.) is a major cereal crop for livestock feed, human nutrition and also raw materials for industries. Maize, a popular staple food crop in the north, west, and mid altitudes of Nigeria, is grown either as mono or mixed crop in the backyard gardens, as a field or plantation crop. It has annual maize production in excess of 7 million metric tons. In terms of volume produced, maize is the third most important cereal grown in Nigeria after sorghum and millet.

Maize will continue to play a large and important role in Nigeria's food production.

In the early 1960s, scientists at Purdue University discovered a peculiar gene that significantly increased the level of two essential amino acids, lysine and tryptophan, in the maize grain. The name "opaque-2" was coined for this gene because it gave the kernels a chalky appearance. The gene also conferred low yields, susceptibility to many diseases and pests, and higher grain moisture at harvest. Subsequently, over a period of one decade,

CIMMYT scientists used conventional breeding employing quantitatively inherited modifier genes to change the appearance of the "opaque-2", and to improve yield and other agronomic traits while maintaining the protein quality. CIMMYT designated the new product as "quality protein maize" (QPM). QPM looks and tastes like normal maize and yields as much or more, but it contains nearly twice the quantity of the essential amino acids, lysine and tryptophan, which are essential building blocks of protein in humans, and mono-gastric animals like poultry and pigs (CIMMYT, 2000). The nutritive value of QPM protein approaches that of protein from milk (NRC, 1988). The biological value of common maize protein is equal to about 40% that of milk protein, whereas the biological value of QPM protein is about 90% of that of milk protein. This could almost fulfill the protein needs of malnourished children. Children can meet 90% of their daily protein needs by eating 175 grams of QPM - equivalent to 250 grams of normal maize. CIMMYT studies indicate that QPM could contribute to reducing protein deficiencies, particularly in young children. In other studies in Latin America and recently in Ghana, malnourished children were restored to health on controlled diets using QPM (CIMMYT, 1999). Food security in the broad sense includes sufficient food production in the agricultural sector as well as human nutrition and health aspects (Jansonius, 1988). In countries like Nigeria, Ethiopia and Africa, low income people have limited access to protein sources like meat, eggs and milk. Quality protein maize could be a good source of protein for these people. It could also be used as a feed to promote poultry and pig production. These enterprises may enhance food security and increase disposable income for farm families.

Worldwide losses in maize due to diseases were estimated to be about 9% in 2001-3 (Oerke, 2005). Grain yield losses ranging from 0 -70% have been reported

due to some of the major diseases which depend on factors such as genetic constitution of the cultivars and stage of growth at the time of infections. Quality protein maize varieties are known to be more vulnerable to diseases because of the soft floury endosperm of the Opaque-2 maize which foster fungal growth (NRC, 1988). Benti and Ransom (1993) also reported susceptibility to major leaf diseases as a major weakness of CIMMYT maize germplasm under Ethiopian conditions. Amongst the diseases Gray leaf spot, which has a very recent history of occurrence in Africa, is becoming the most important threat to maize production in the country (Dunkle and Levy, 2000). It is widely distributed and has caused serious grain yield losses in the major maize growing regions of Nigeria. This paper attempts to review on the mode of spread, importance and sustainable management of Gray leaf disease.

#### **Prevalence and Distribution of Gray leaf spot disease**

Grey leaf spot (GLS) caused by the fungus, *Cercospora zae-maydis* Tehon & E.Y Daniels, and to a much lesser extent by *Cercospora sorghi* var. *maydis*, was first described on maize in Illinois, USA in 1924 (Tehon and Daniels, 1925). It is currently recognized as one of most important, yield-limiting diseases of maize worldwide (Latterell and Rossi, 1983 Ward and Nowell, 1998), and is prevalent throughout the USA, Central America, Europe, South-East Asia, India, China and Africa (Ward *et al.*, 1999). The first reports of GLS in Africa came from South Africa in 1988. Initially, the main foci for GLS were in KwaZulu Natal Province in South Africa, from where it has spread northwards into the major maize-growing regions of the continent (Ward *et al.*, 1999). It was reported in Kenya and Zimbabwe during the 1995 growing season (Kung'u and Boa, 1997), together with reports from Cameroon, Democratic Republic of Congo, Malawi, Mozambique, Nigeria, Swaziland,

Tanzania, Uganda and Zambia. Since its emergence in Africa, GLS has become an increasingly important constraint to maize production, and currently poses a serious threat to food security in Africa. Gray leaf spot, which has a very recent history of occurrence in Africa, is becoming the most important threat to maize production in the country (Dunkle and Levy, 2000). It is widely distributed and has caused serious grain yield losses in the major maize growing regions of Nigeria.

#### **Identifying the Gray leaf spot disease**

Two isolates exist in Nigeria, classified as A (cercosporin producing) and B (non cercosporin producing). The growth characteristics, conidia dimensions, and the production of cercosporin of the two isolates from naturally infected plants and from agar, showed that they were distinct. The presence of two isolates has been reported by Dunkle and Levy (2000) and Okori *et al.* (2003) and classified as groups 1 and 2. The isolates from Africa were morphologically indistinguishable from the USA isolates in both groups, but, like isolates in group 2, they grew more slowly and failed to produce detectable amounts of cercosporin in culture (Latterell and Rossi 1983). It has been reported that group 1 was prevalent in USA, while group 2 was found in both Africa and USA. Although this disease has been reported in the USA prior to the first report in Africa, there are claims that group 2 might have originated from Africa. Studies in East Africa show that group 2 pathotype is prevalent and predominant, but the origin and spread of the disease remain uncertain in some African countries, such as Cameroon and Zimbabwe where the disease has attained epidemic levels. The resurgence of the disease in Nigeria since it was first reported in 1996 requires further investigation to arrest its spread to all other maize-growing regions in the country. Although the two isolates with some differences in morphology and production of cercosporin, are known to

produce the same symptoms on maize, these two pathogenic species with unknown abilities might combine and produce virulent pathotypes.

Initial gray leaf spot symptoms on leaves are characterized by a small, pinpoint lesions surrounded by yellow halos. At this stage, it can be hard to correctly identify the disease, but as lesions mature, they elongate into narrow, rectangular, brown to gray spots. Lesions expand parallel to leaf veins and may become 5 – 15 mm long to 2 - 5 mm wide. The lesions occur on leaf blade and sheaths and are mostly isolated, but can form contiguously to give long stripes. Symptoms usually develop on the lower leaves of the maize plant initially, and as more lesions form, individual lesions coalesce, resulting in severe leaf blighting of the whole plant. Netting or banding can occur within these lesions. A grayish white bloom is produced on the lesions when the fungus produces conidiophores and conidia (Latterell and Rossi 1983).

#### **Conditions Favoring Disease Development**

*Cercospora zeae-maydis* is a polycyclic, facultative pathogen (Chupp, 1953). Most reports suggest that it is only capable of infecting maize (Beckman and Payne, 1982), although Shurtleff (1980) suggests that Sorghum may also be a host. The pathogen over winters in infested crop debris (Beckman and Payne, 1982), and this is widely believed to be the primary source of inoculum (Beckman and Payne, 1982). The subsequent development of epidemics of GLS depends on environmental conditions i.e. disease development requires a high relative humidity (>95%), cool, cloudy conditions with an extended dew period (Latterell and Rossi, 1983; Anderson, 1995) and temperatures of 22-30°C (Beckman and Payne, 1982). As temperatures rise in the spring, the fungus on corn residue produces spores that splash onto young corn leaves, which is why symptoms are

commonly observed first on the lower leaves of the plant. Wind may transport spores from a field with corn residue to neighboring fields. *Cercospora zeaemaydis* spores can cease development

Gray leaf spot can have a substantial impact on yield under favorable conditions. The relationship between the amount of leaf tissue affected by gray leaf spot and the amount of yield loss is unclear. However, the lesions reduce the amount of photosynthetic areas on leaves available to contribute carbohydrates to the developing the economic impact will be less. Yield losses ranging between 10% and 50% have been reported (Table 1), and the disease is

during low humidity periods, and then resume the infection process once humidity rises.

#### Disease Impact

grain. Yield loss may depend on the number of lesions and how far up in the canopy they occur as the plant enters tasseling and pollination. If lesions have reached the ear leaf or higher during the two weeks before and after tasseling, yield loss could occur. If lesions develop on upper leaves later in the season, considered to pose a serious threat to food security in Africa.

Table 1. Estimated corn yield loss based on percentage of infected leaf tissue.

Percentage Ear Leaf Area Affected by Early Dent Stage (R5)	Approximate Yield Loss
5% or less	0-2%
6-25%	2-10%
25-75%	5-20%
75-100% (leaf death)	15-50%

Source: Patrick Lipps, 1998. Gray leaf spot and yield losses in corn. *Crop Observation and Recommendation network*. Issue 98-23.

#### Performance of QPM in relation to diseases resistance

In Nigeria and several countries in Africa several researches were conducted to screen QPM varieties obtained from various sources for resistance to the disease (Table 2). Observations for agronomic characters show clear

differences among the QPM hybrids in their reaction to leaf diseases. Almost all of varieties tested were susceptible to at least one of the important leaf diseases. The results suggest that though there were some reasonable levels of tolerance to this disease, there are no immune varieties.

Table 2. Summary of major agronomic traits of QPM hybrids evaluated in strip test in 2000

Pedigree	Grain yield (q/ha)	Days to silking (no.)	Plant height (cm)	Ear height (cm)	Lodging (%)	Diseases (1-5)*		
						Rust	Blight	Gray leaf spot
1. P62.. X CML150 X CML140	85	85	210	110	3.6	1.7(1-2.5)	1.52(1-3.5)	1.6(1-4)
2. Obatanpa	111	84	234	125	9.5	1.8(1-3.5)	2(1-3.5)	2.25(1-4)
3. CML141 X CML144 X <sup>*</sup> CML176	80	86	216	108	11.3	1.6(1-3.5)	1.8(1-2.5)	1.2(1-3)
4. CML175 X CML176	77	86	215	104	15.0	1.9(1-4)	1.6(1-5)	1.0(1-2.5)
5. CML144 X CML159 X CML176	86	87	222	116	11.3	1.3(1-2.5)	1.7(1-3.5)	0.95(1-1.5)
6. GH 132-28	91	77	212	105	12.8	1.9(1-5)	1.9(1-3.5)	1.4(1-4)
7. BH540 (Local check)	87	88	218	114	16.4	1.5(1-1.5)	1.37(1-2.5)	1.8(1-4)
Mean	88	86	218	112	11.4	1.7	1.7	1.5

( ) Indicates the range of scores for disease severity

\*1 Indicates resistant and 5 Susceptible.

Source: Leta *et al.*, 2001

### Gray leaf spot Disease Management for sustainable production of QPM in Nigeria

Fundamentally, there are only two disease management strategies: those which reduce the initial inoculum and those which reduce the spread of the pathogen within affected areas. This disease could have one or more control tactics that affect either of these strategies. The management strategy needs to consider both the tools available and those that could be developed. At this time it becomes important to integrate the work within a comprehensive crop management system. Far too often good ideas for disease control fail because of interference with agronomic or entomological actions. A management strategy for the current decade must be comprehensive (Schreiber *et al.*, 1987).

### Using $X = X_0 e^{rt}$ for Plant Disease Management

Above equation proposed by Vanderplank (1963), for polycyclic

diseases, could be used for disease management. This reveals that final amount of disease (X) depends on (a) amount of initial inoculum ( $X_0$ ), (b) rate of disease development (r) and (c) duration of disease development (t). Suitable manipulation that can bring any reduction in any one or more of the above three factors will reduce the final disease severity (X).

### Reducing amount of initial inoculum ( $X_0$ )

The practices discussed under sanitation viz. seed certification, rouging, burning of crop debris and other cultural and chemical methods are popular among the growers. Nurserymen are practicing sanitation. Use of disease/ pathogen free seed/ planting material, treating them suitably, changing the beds for raising seedlings and use of polythene as mulch for soil solarization is becoming popular as

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