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Identified Major Disease Hazards of Maize Production in Southern Nigeria

Die wichtigsten Krankheitserreger im Maisanbau in Südnigeria

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1. Introduction

Maize (Zea mays L.) is predominantly grown in the rainforest and Guinea savanna vegetation zones of Nigeria. The rainfall pattern is bimodal in the rainforest zone with maximum precipitations in the months of June–July and September which makes a two-season maize production possible in the zone. In some parts of the Guinea Savanna vegetation, however, one season crop of maize is grown because the rainfall pattern is that of a gradual rise which continues from March to a peak in September and quickly drops in October at the onset of the harmattan. Higher maize yields have been reported in this zone (15).

The lower maize yields of the rainforest zone have been attributed to excessive rainfall, high humidity and drizzly morning weather of the months of May, June and July, resulting in poor solar radiation during the grain-filling period. Coupled with these are heavy leaf disease infections, poor or lack of grain drying and storage facilities, delayed harvest and seed damage by diseases and pests. These factors reduce maize yield significantly (Obi, unpublished data). Although the second season crop of maize (August–November) has an adequate solar radiation for higher maize yields, the first season maize (March–July) outyields the second season because of maize streak virus (MSV), stem borer and water stress effects which are more predominant during the late season.

The health of maize plants is important to Nigeria's progress and success of the Green Revolution campaign efforts of the Federal Government of Nigeria. Apparently, a maize plant is susceptible to a number of diseases which attack the leaves, culms, seeds, roots and the reproductive parts and reduce yield and quality.

A preliminary list of the plant diseases in Nigeria was compiled by West (19). In that list the disease of economic importance reported on maize then were Fusarium spp., Helminthosporium turcicum Pass., Ophiobolus heterostrophus Drecks., Physoderma zeae-maydis Shaw., Ustilago zeae (Beckin) Ling and Streak Virus disease (2, 5). In 1950, an outbreak of Puccinia polysora Underw. reached epiphyto-

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tic proportions in Nigeria and led to the need for the improvement of the existing maize cultivars (4). Oyekan and Obajimi (13) observed rust, blight, leaf spot, grey spot and virus streak infections on popcorn cultivars at Ikenne in western Nigeria. Earlier on, Jemmett and Peacock (10, 14) drew attention to many insect pests of maize in the country. Those of economic importance then were, the weevils, lepidopterous stem borers and "army" or "cut" worms. Sutherland (17) showed that stem borers caused about 1.4 m loss from annual graminaceous crops alone. Busseola fusca (Fuller) was first reported on maize by Peacock (14). Lamborn (11) identified Sesamia calamistis Hamps, Eldana saccharina Walker; and B. fusca as seriously reducing maize yields in Nigeria. Usua (18) associated maize lodging with S. calamistis attack. Also, Adesuyi and Shode (1) estimated about 62% and 78% insect damage of stored FARZ-26 and NS-1 maize varieties, respectively, in Nigeria.

Yearly maize yield losses in Nigeria range from 30–60% resulting from maize disease infections. Yield losses of about 40% have been reported for rust infections (3), whereas H. maydis attack has been shown to reduce yield by about 37% (6). Fajemisin and Okuyemi (7) estimated about 33% yield loss of maize due to Curvularia leaf spot infections. MSV infestations have also been reported to reach epiphytotic proportions in parts of Nigeria (8). Although, yield losses for the MSV and Brown spot (Physoderma zeaemaydis Shaw) diseases of maize in Nigeria have not been adequately estimated, the MSV and Brown Spot infections could reduce yield by up to 50% through poor grain formation and barrenness (MSV) and excessive lodging due to Brown spot attack. Both diseases could lead to complete crop failure if not adequately controlled. Apart from sporadic outbreak of MSV during the second season crop of maize (8) no other pathogen was of great concern and danger to maize production until in the most recent years. The objectives of these studies were to evaluate local cultivars of maize grown by farmers in the rainforest and parts of the Guinea savanna vegetation zones of Nigeria for natural leaf disease infections and to identify the most serious pathogen(s) and/or pests of maize which are likely to limit maize production and the progress of the Green Revolution campaign of the Federal Government of Nigeria.

2. Materials and Methods

Four hundred and eighty one (481) local maize cultivars collected from Anambra, Bendel, Benue, Cross River, Imo, Kwara, Oyo and Rivers States of Nigeria were grown in single replicated plots measuring 0.3 m x 1.8 m. Two improved and released varieties TZB-FARZ-34 (white composite, open pollinated dent) and 096EP6-FARZ-23 (yellow synthetic, open pollinated flint) obtained from the Ministry of Agriculture and Natural Resources (MANR), Nsukka, Nigeria were included in the study as control. The improved varieties were grown in two replicated plots each measuring 0.3 m x 1.8 m. The experimental site had been previously cropped with cassava (Manihot esculenta Crantz) and laid fallow for two years before the maize experiment. Maize planting was delayed until May 27–June 3, to maximize infections and disease development by all available pathogens and to avoid or minimize disease escape by some of the cultivars (12). Four seeds/hill of each cultivar were planted by hand and the seedlings were thinned down to two plants/hill, two weeks after emergence, retaining 10 plants of each cultivar/plot.

2.1 Disease rating

The plants were rated for disease severity and incidence 2–14 days after artificial pollinations of all the cultivars. Disease rating was on a 0–5 scale, where: 0 = absence of disease infection, 1 = 1–10% total leaf area infected, 2 = 11–30% total leaf area infected, 3 = 31–50% total leaf area infected, 4 = 51–70% total leaf area infected, and 5 = 71–100% total leaf area infected.

The rating scale was designed to show absence and/or magnitude of presence or severity of disease infections under natural field conditions. Per cent disease severity (% D.S.) and disease incidence (% D.I.) were calculated as follows:

$$\%\ \text{D.S.} = \frac{\text{Number of leaves with infections/plot}}{\text{Total number of leaves/plot}} \times 100$$

$$\%\ \text{D.I.} = \frac{\text{Number of plants with infections/plot}}{\text{Total number of plants/plot}} \times 100$$

A leaf was regarded as infected if the lesion or injury done by the pathogen or pest was obvious. However, dead or dried leaves from the bottom of the plant were not included in the disease score because these were regarded as normal senescence of the leaves.

3. Results

The results (Tables 1, 2 and 3) clearly show that rust infections caused by Puccinia polysora reached epiphytotic proportions in the Nsukka Agricultural zone during the first part of the 1980 rainy season crop maize. The improved varieties (Table 3) had a similar trend in disease severity and incidence as the local cultivars (Tables 1 and 2). For the local cultivars P. polysora had a mean disease severity of 3.2 which corresponded to 31–50% of total leaf area infected of the 481 cultivars. A mean of disease severity of 4 which corresponded to 51–70% total leaf area infected by rust was observed for the two improved varieties. The local cultivars (481 total) had a mean disease incidence of 78.6% compared to mean disease incidence of 65% observed for the improved varieties. For the local cultivars the modes for disease severity and incidence for rust infections were 5 and 100%, respectively. Apparently, a mode of zero was observed for disease incidence and severity for the other pathogens identified in these studies (Tables 1 and 2).

The weather conditions were optimum for rust and other leaf disease infections during the period (16). The average relative humidity for the months of April to August was 85% in the mornings (0900 hr. GMT) and 72.8% in the afternoon (1500 (1500 hr GMT). The mean daily temperatures for the same period ranged from 21 to 29 °C, and a mean monthly rainfall of 231.4 mm corresponded to a mean of 16 rain days per month. Other maize disease infections observed in the order of their mean severity and incidence were H. maydis (D.S. = 1.1, D.I. = 27.6%), Curvularia spp (D.S. = 0.5, D.I. = 8.6%), Fusarium spp (D.S. = 0.2, D.I. 3.4%), H. turcicum (D.S. = 0.2, D.I. = 0.3%). Also, for H. maydis, stemborer, Curvularia and Fusarium spp the mode for disease severity was 0.0 and ranged from 0–5, and the mode for disease incidence was 0.0% and ranged from 0–100%. The results are summarized in Tables 1 and 2. Physoderma Zeae maydis Shaw. and Piricularia grisea Cke Sacc. which had been reported on maize in southern Nigeria were not observed in these studies. Also no resistance reactions were observed in the lesions of the infected local cultivars and the improved varieties. The low disease scores of some of the cultivars were probably due to low inoculum potential of the particular pathogen. Fajemisin (9) could not identify extremely resistant cultivars in his collection. However, he observed "moderate" resistance to some of the pathogens. Presently, artificial inoculations are being used to classify the cultivars into diseases reaction groups or types.

Table 1. The mean, range and mode of disease severity of rust (Puccinia polysora), blight (Helminthosporium maydis, H. turcicum) Curvularia and Fussarium spp. Maize streak virus, and stem borer damage on 481 local maize cultivars

	P. polysora	H. maydis	H. turcicum	Curvularia spp.	Fusarium spp.	MSV	Stem borer
Mean*	3.2	1.1	0.2	0.5	0.2	0.04	0.2
Range	0–5	0–5	0–5	0–5	0–5	0–3	0–5
Mode	5	0	0	0	0	0	0

* Figures are scores on a scale of 0–5, where 0 = absence of disease infection; 1 = 1–10% total leaf area infected; 2 = 11–30% total leaf area infected; 3 = 31–50% total leaf area infected; 4 = 51–70% total leaf area infected and 5 = 71–100% total leaf area infected

Table 2. The mean, range and mode of percent disease incidence or rust (Puccinia polysora), blight (Helminthosporium maydis, H. turcicum), Curvularia and Fusarium spp., maize streak virus and stem borer damage on 481 local maize cultivars

	P. polysora	H. maydis	H. turcicum	Curvularia spp	Fusarium spp	MSV	Stem borer
Mean*	78.6	27.6	2.2	8.6	3.4	0.3	2.2
Range	0–100	0–100	0–100	0–100	0–100	0–30	0–100
Mode	100	0	0	0	0	0	0

* Figures represent mean percentage of plants infected/plot. There were ten plants/plot.

Table 3. The mean disease severity and percent incidence of rust (Puccinia Polysora) blight (Helminthosporium maydis, H. turcicum) Curvularia and Fusarium spp, Maize streak virus (MSV) and stem borer damage on two improved varieties of maize

	P. polysora	H. maydis	H. turcicum	Curvularia spp	Fusarium spp	MSV	Stem borer
TZB-FARZ-34	5(80)*	1.4(20)	0(0)	0(0)	0(0)	0(0)	0(33)
096EP6-FARZ-23	3(50)	0(0)	0.7(10)	0(0)	0(0)	0(0)	0(0)

* Figures in brackets represent percentage disease incidence, while unbracketed figures represent scales of disease severity where 0 = absence of disease infection; 1 = 1–10% total leaf area infected, 2 = 11–30% total leaf area infected, 3 = 31–50% total leaf area infected, 4 = 51–70% total leaf area infected and 5 = 71–100% total leaf area infected

4. Discussion

The results of these studies show a looming danger to maize production in the rainforest and parts of the Guinea Savanna vegetation zones of southern Nigeria. If something is not done properly, timely, steadily and fast the Nigeria maize economy and industry is bound to witness severe rust epiphytotics and of other fungal maize infections, especially H. maydis, Curvularia and Fusarium spp. As has been rightly pointed out, disease attack and poor weather conditions limit higher and good quality maize yields in the rain forest zone of Nigeria (15). The disease problem could be solved by using disease free seeds of resistant maize varieties and/or appropriate chemical or cultural practice control measures. Apparently, no resistant reaction source could be identified among the local cultivars and the improved varieties under investigation. There is not much one can do to change the poor weather conditions which have been deteriorating for the past three years.

Having said these, there is something that is right that could be done to save the Nigerian maize industry from imminent danger and collapse. This involves, in part, a proper planning for maize production in Nigeria. It has been shown that Guinea Savanna (intermediate zone) maize yields higher than the rainforest zone crop (15). Also, the first season crop of the rainforest zone outyields the second season crop of maize due to stem borer damage, MSV attack and water stress during the grain-filling period (15). From the results of these studies it appears that maize production during the second part of the rainy season could outyield the first season if some or all the bottle necks or limitations of the second season are removed. For example, the stem borer and MSV problems could be solved by research as to which chemicals and/or resistant maize varieties will offer best protection. Similarly the water stress problem which lasts for about one month could be solved by developing irrigated maize farms, a responsibility which could be handled by the river basin development authorities. Maize produced during this period will not only out yield the rainy season crop but is bound to be of better quality. The drying problems will be very much reduced since the time of harvest would coincide with the harmattan season.

It is, therefore, being recommended as a matter of priority and urgency that Nigeria plans for an extensive national use of disease resistant maize varieties. Initially, resistance should be found to P. polysora, H. maydis and Curvularia leaf spot, MSV and stemborer, and farmers should be advised to plant the first part of the rainy season crop as early as weather conditions can permit (late March or early April). For the second part of the rainy season crop of maize, resistant varieties have to be developed especially against MSV, stem-borer and even against water stress. However, irrigation systems should be provided to deliver water to maize farms during the grain-filling water-stress periods. Irrigation could be extended to the early part of the first season crop (March—April) when rainfall is most unpredictable. The results of these studies show that the local unimproved maize cultivars grown by village farmers may act as inoculum reservoirs for these pathogens and pests since none of them showed resistant or tolerant reactions to the pathogens. The cultivars will either be replaced by resistant varieties to prevent inoculum build up, or improved as they are with resistant genes against the problem pathogens incorporated. Since the two improved varieties included as a check did not perform better in disease reaction than the local cultivars emphasis should, therefore, be placed on disease resistance as well as other agronomic characteristics of the varieties before their release.

5. Summary

Disease rating of naturally infected 481 local maize cultivars collected from 8 states in the rainforest and parts of the Guinea Savanna zones of Nigeria revealed that rust infection caused by Puccinia polysora was an important hazard to maize production in southern Nigeria. Out of the 481 cultivars planted 378 had 31–70% total leaf area infected by rust (P. polysora). This means that on the average 78.6% of the total plants/plot (ten plants/plot) were infected by rust. Similarly, about 133 cultivars had leaf blight infections caused by H. maydis; this corresponded to 1–30% total leaf area infected. The two improved varieties on the average had 65% of the total plants/plot infected by rust. Disease incidence and severity of the other pathogens on the improved varities were generally low. Rust epiphytotics are, therefore imminent in southern Nigeria if not checked adequately and fast. Other maize disease hazards identified in order of their importance were H. maydis, Curvularia and Fusarium spp, H. turcicum, stem borer and maize streak virus. The solution to the problems includes use of resistant varieties, well planned maize production programme, and chemical control measures. To avoid maize disease epiphytotics in the rainforest and parts of the Guinea Savanna vegetations zones of Nigeria it is recommended that research institutes and universities involved in maize improvement programme should emphasize maize disease problems in maize production and in their research proposals or programmes.

Zusammenfassung

Die Auswertung von 481 natürlich infizierten lokalen Maiskultivaren, die in 8 Staaten des Regenwaldes und Teile der Guinea Savanna Nigerias gesammelt wurden, ergab, daß die von Puccinia polysora verursachte Rostkrankheit für den Maisanbau in diesen Regionen eine bedeutungsvolle Gefahr ist.

Von den 481 Kultivaren waren 381 zu 31% bis 70% von Rost befallen (gemessen an den befallenen Blattoberflächen). Durchschnittlich waren 78,6% der Gesamtpflanzen je Parzelle (10 Pflanzen pro Parzelle) vom Rost befallen. 133 Kultivare waren von H. maydis (leaf blight) infiziert – dieses entspricht einem Gesamtblattbefall von 1% bis 30%.

Die 2 verbesserten Varietäten zeigten auf durchschnittlich 65% der Gesamtpflanzen pro Parzelle einen Rostbefall. Vorkommen und Bedeutung von anderen Erregern waren hier allgemein gering.

Ansonsten wurden folgende Krankheiten gefunden: H. maydis, Curvularia und Fusarium spp., H. turcicum, Stengelbohrer und maize streak virus.

Diese Probleme könnten durch den Anbau resistenter Sorten, gut geplante Anbauprogramme und chemische Bekämpfungsmaßnahmen gelöst werden.

Um eine weitere Ausbreitung des Rostes in den Regenwald- und Savannazonen

Südnigerias zu verhindern, empfiehlt es sich, daß Forschungsinstitute und Universitäten, die sich mit Maisprogrammen befassen, die Krankheitsprobleme der Maisproduktion schwerpunktmäßig in ihre Forschungsarbeiten aufnehmen.

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