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RELATIONSHIP BETWEEN SOME WEATHER FACTORS, *MAIZE STREAK VIRUS* GENUS *MASTREVIRUS* INCIDENCE AND VECTOR POPULATIONS IN NORTHERN NIGERIA

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Abstract: Some aspects of the epidemiology of *Maize streak virus* (MSV) genus *Mastrevirus* concerning virus incidence, vector populations and some environmental factors were investigated in field experiments conducted over a three year period (2000–2002) at Samaru, northern Nigeria. Significant positive correlations were obtained between number of leafhoppers caught and MSV incidence and age of plant at infection and also with temperature. Also significant negative correlations were obtained between MSV incidence and mean relative humidity; between number of leafhoppers and age of plants and with mean rainfall. Leafhopper vectors caught included *Cicadulina arachidis* China, *C. mbila* Naude, *C. triangula* Ruppel and *C. similis* China, in order of abundance. Leafhopper incidence was highest in the months of September and October.

Key words: *Maize streak virus*, *Mastrevirus*, weathaer factors, leafhopper, *Cicadulina*

INTRODUCTION

Maize streak virus (MSV) genus mastrevirus is endemic on maize in Africa especially Nigeria (Storey 1978; Bock 1974; Le Conte 1974; Fajemisin et al. 1976; Rossel and Thottappilly 1985; Okoth and Dabrowski 1987; Okoth et al. 1987). It is one of the most important factors limiting the production of maize (*Zea mays* L.) in Nigeria (Fajemisin et al. 1986a). The virus is transmitted persistently by several species of leafhoppers, *Cicadulina* spp. (Storey 1975; Fajemisin et al. 1976; Dąbrowski and Tang 1986; Olojede 2001; Alegbejo et al. 2002). Incidence of MSV may be insignificant in some years but epidemics of the disease can devastate crops with yield losses of up to 70–100% (Kim et al. 1981; Fajemisin et al. 1986a). Epidemics have been reported in Nigeria in 1966, 1971, 1973, 1976, 1983 and 1984 (Eseman 1966; Fajemisin and Shoyinka 1976; Kim et al. 1981; Effron et al. 1989). MSV is not transmitted mechanically, via pollen or through seed. Therefore, the ecology and epidemiology of the disease depends entirely on the movements of its vector species which feed and reproduce readily in most major cereals and annual grass weeds. This investigation was therefore initiated to determine some aspects of the epidemiology of MSV in northern Nigeria where the disease is known to occur consistently over the years and where 75–100% of maize plants can be infected and hence a hotspot area (Anonymus 1983).

MATERIALS AND METHODS

The experiment was conducted during the wet season over a three year period 2000–2002 at the Institute for Agricultural Research (IAR), Samaru (latitude 11°11'N, longitude 7°38'E, elevation 686 m) northern Guinea Savanna of Nigeria where natural sources of virus and its vectors are abundant. Two maize cultivars, 1WDSTRCO (streak resistant) and Gusau SI-pool 16 (streak susceptible), obtained from the germplasm of the International Institute of Tropical Agriculture (IITA), Ibadan were used. The experiment was established on 8th, 9th and 12th June 2000, 2001 and 2002 respectively using a split-plot design. Each maize cultivar was allocated to a sub-plot which consisted of five ridges 6.0 × 3.0 m separated by a border zone of 1.0 m, while plots were separated by a border zone of 2.0 m. The main plot was MSV incidence. Two seeds were sown per hole with an intra-row spacing of 25 cm. Seedlings were fertilized at 2 weeks after germination (WAG) with N.P.K. (15:15:15) at the rate of 250kg/ha and with N.P.K. (27:10:10) at 6 WAG at the same rate. The field was hoe-weeded four times at 3, 6, 9 and 12 WAG. Leafhopper vectors of MSV were caught with a sweep net at weekly intervals in each sub-plot (five sweeps were made per sub-plot) starting from 1 WAG till the end of the experiment (October). MSV-infected plants were monitored weekly starting from 1 WAG till the end of the trial. Leafhopper catches and observations on MSV incidence were made on the same day. Leafhoppers caught in each subplot were counted seperately. Weather factors were obtained from the agroclimatological unit of the Institute and related to the incidence of the virus and leaf hoppers. The weight of grains harvested from each sub-plot was recorded and related to annual incidence of MSV. MSV was identified by ELISA tests (Pinner and Markham 1990). Data were analysed using the analysis of variance after which the standard error of difference (SED) was used to separate means that differed at 5 percent level of significance. Yearly differences in average of leafhoppers caught, MSV-infected plants/sub-plot and climatic factors during the observation period, were determined by the standard error of difference. The species of *Cicadulina* caught on yearly basis were also analysed. Correlation analysis was also determined for weather factors and number of leafhoppers caught per week, incidence of MSV per week and age of plants (in weeks).

RESULTS AND DISCUSSION

The test virus was positively identified as MSV using ELISA test. Infected plants were characterised by broken but almost continuous, narrow chlorotic streaks centred on secondary and tertiary leaf veins and distributed uniformly over the leaf surface. The parallel chlorotic streaks were partially to almost completely fuse, leaving irregular green lines or island centred between veinlets. The green stripes varied from a few millimeters to several centimeters in length and from 0.5 to 1 mm. Symptoms began 2–3 WAG and in severe cases very small cobs were produced.

There was a significant positive correlation between the following factors: number of leafhoppers caught per week and incidence of MSV (Tables 1–3); number of leafhoppers caught and mean temperature; number of leafhoppers caught and sunshine hours; MSV incidence and age of plants; MSV incidence and mean temperature (Tables 1–3). However, a significant negative correlation was observed between number of leafhoppers caught and age of plants; number of leafhoppers caught and mean rainfall; MSV incidence and mean rainfall; MSV incidence and mean relative humidity (Tables 1–3).

Generally, periods and years of high rainfall coincided with periods and years of low leafhopper incidence (Table 4). Years of high incidence of leafhopper vectors coincided with years of high MSV incidence and vice versa (Table 4). The streak resistant cultivar 1WD STR CO, was less susceptible to MSV than the streak suscep-

Table 1. Correlation coefficients of the effect of climatic factors and leafhopper population on the incidence of *Maize streak virus* (MSV) at Samaru in the 2000 rainy season

Variables	Correlation coefficients						
	Vi	V_2	V_3	V_4	V_5	V_6	V_7
V_1=Incidence of MSV	+1.00						
V_2=Number of leafhoppers caught per week	+0.70	+1.00					
V_3=Age of plants (in weeks)	–0.65	+0–61	+1.00				
V_4=Mean temperature (°C)	+0.70	+0.80	+0.75	+1.00			
V_5=Mean sunshine hours	+0.58	–0.62	+0.70	+0.63	+1.00		
V_6=Mean rainfall (mm)	–0.65	–0.70	–0.50	–0.42	–0.43	+1.00	
V_7=Mean relative humidity (%)	–0.63	–0.69	–0.49	–0.43	–0.80	+0.81	+1.00

Correlation coefficient at p = 0.05 = 0.53

Table 2. Correlation coefficients of the effect of climatic factors and leafhopper population on the incidence of *Maize streak virus* (MSV) at Samaru in the 2001 rainy season

Variables	Correlation coefficients*						
	V,	V_2	V_3	V_4	V_5	V_6	V_7
V_1= Incidence of MSV	+1.00						
V_2= Number of leafhop per caughtper week	+0.72	+1.00	–				
V_3=Age of plants (in weeks)	–0.63	+0.68	+1.00				
V_4=Mean temperature (°C)	+0.78	+0.85	+0.79	+1.00			
V_5=Mean sunshine hours	+0.61	–0.67	+0.75	+0.68	+1 .00		
V_6=Mean rainfall (mm)	–0.67	–0.74	–0.53	–0.47	–0.45	+1.00	
V_7=Mean relative humidity (%)	–0.65	–0.72	–0.51	–0.46	–0.83	+0.85	+1.00

Correlation coefficient at p = 0.05 = 0.56

Table 3. Correlation coefficients of the effect of climatic factors and leafhopper population on the incidence of MSV at Samaru in the 2002 rainy season

Variables	Correlation coefficients						
	V_1	V_2	V_3	V_4	V_5	V_6	V_7
V_1=Incidence of MSV per week	+1.00						
V_2=Number of leafhop per caught	+0.72	+1.00					
V_3=Age of plants (in weeks)	–0.67	+0.63	+1.00				
V_4=Mean temperature (°C)	+0.73	+0.82	+0.76	+1.00			
V_5=Mean sunshine hours	+0.60	–0.60	+0.71	+0.62	+1.00		
V_6=Mean rainfall (mm)	–0.66	–0.71	–0.55	–0.45	–0.46	+1.00	
V_7=Mean relative humidity (%)	–0.60	–0.67	–0.48	–0.40	* –0.82	+0.80	+1.00

Correlation coefficient at p = 0.05 =0.55

tible Gusau 91-Pool 16 (Table 4). Streak incidence was highest in 2001, followed in descending order by 2000 and 2002.

The leafhopper vectors caught included *Cicadulina arachidis* Chida, C. *mbila* Naude, *C. triangula* Ruppel and *C. similis* China, in order of abundance (Table 5). This trend was maintained during the three years of the investigation (Table 5). Leafhopper incidence was highest in the months of September and October of each year. The investigation on the epidemiology of MSV in northern Nigeria, indicate a strong relationship between MSV, prevailing or environmental temperature, sunshine hours, age of plants and number of leafhoppers caught. The most likely explanation for this relationship would appear to be the effect of these factors on the development and movement of leafhopper population and the growth of alternate hosts of the virus (Ekukole 1985; Dąbrowski et al. 1991; Olojede 1989, 2001). This is in line with the observations of Fajemisin et al. (1986b) who reported that MSV incidence is closely associated with vector population dynamics which in turn, is influenced by rainfall, temperature and availability of alternate hosts. *Cicadulina*

Table 4. Relationship between the incidence of MSV at Samaru and variation in the weather (2000–2002)

Year	Average of Leafhoppers caught/plot	Percentage of MSV -infected plants per plot				Climatic factors during the observation period (June–October)			
		IWSTRCO (SR)*	Wt. of grains (t/ha)	Gusau SI-Pool 16 (SS)**	Wt.of grains (t/ha)	Average temp (°C)	Mean Sunshine (hrs)	Mean Rainfall (mm)	Mean Relative humidity (%)
2000	94.31	9.24	6.92	54.50	6.73	24.02	6.50	68.12	71.21
2001	100.20	12.03	641	65.70	5.89	27.06	7.60	64.20	40.02
2002	90.1	7.10	7.40	50.01	6.90	23.21	6.20	72.09	73.30
S.E.D. (p=0.05) Between years	9.02	2.60	0.13	5.60	0.12	3.72	2.01	6.01	3.01
S.E.D. (p=0.05) within year	7.12	2.16	0.12	3.91	0.10	2.04	1.67	4.15	2.03

(SR)* = Streak resistant
(SS)**= Streak susceptible

Table 5. Incidence of *Cicadulina* species per plot at Samaru between 2000 and 2002

Species	Number of insects caught per year		
	2000	2001	2002
		No %	
Cicadulina mbila Naude	31.98	31.12	32.29
Cicadulina similis China	12.34	12.83	11.81
Cicadulina arachidis China	37.771	37.34	38.42
Cicadulina triangula Ruppel	17.90	18.73	17.48
Total	100 %	100%	100 %

spp. populations increased with the rains reaching its highest in September and October when MSV spread was fastest (Ekukole 1985; Bosque-Perez et al. 1990; Dąbrowski et al. 1991).

Heavy and consistent rains of the 2000 and 2002 growing seasonmight have washed off some of the leaf hoppers from the maize and kept down the population before damage was done. Hence the incidence of MSV in those years were fairly low. In 2001, the rains were early but intermittent, hence there was massive build up, early dispersal and survival of the leafhoppers resulting in high incidence of MSV. The susceptible maize cultivar Gusau Si-Pool 16 had a higher incidence of MSV disease compared with the resistant cultivar 1WD STRCO. The vector with the highest population in maize field was *C. arachidis* and this conforms with earlier findings of Dąbrowski (1987), Okoth and Dąbrowski (1987) and Olojede (1989). The results obtained in the three year study was consistent probably because the trial was located in an environment of high population of leafhopper vectors, and alternate hosts (*Axonopus* sp., *Brachiaria* sp., *Dactyloctenum* sp., *Setaria* etc.) of the virus (Ekukole 1985; Okoth and Dąbrowski 1987; Olojede 1989; Alegbejo et al. 2002). Several of these grass species elicited MSV symptoms as earlier reported by Olojede (2001).

The study indicate that the epidemiology of MSV is fairly complex, involving different leafhopper vectors influenced by climatic factors. It is therefore necessary to combine many control measures into an integrated pest management package for effective control of the disease.

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POLISH SUMMARY

ZALEŻNOŚĆ MIĘDZY NIEKTÓRYMI CZYNNIKAMI KLIMATYCZNYMI, NASILENIEM WIRUSA SMUGOWATOŚCI KUKURYDZY (*MASTERVIRUS*) ORAZ POPULACJAMI JEGO WEKTORÓW W PÓŁNOCNEJ NIGERII

W okresie trzech lat (2000–2003) w doświadczeniach polowych badano wybrane aspekty epidemiologii wirusa pasiastości kukurydzy (MSV) z rodzaju *Mastervirus* w tym nasilenie choroby, liczebność owadów-wektorów oraz wybrane czynniki środowiskowe. Stwierdzono istotną pozytywną korelację między liczbą odławianych skoczków, nasileniem infekcji MSV, wiekiem roślin i temperaturą powietrza. Natomiast istotnie negatywna korelację stwierdzono między nasileniem MSV i średnią wilgotnością powietrza, liczebnością skoczków, wiekiem roślin oraz poziomem opadów. Najwyższą liczebność skoczków obserwowano w miesiącach wrzesień–październik, a wśród nich stwierdzono *Cicadulina arachidis* China, *C. mbila* Naude, *C. triangula* Ruppe, and *C. similis* China, uszeregowane według liczebności w odłowach.