OCCURRENCE AND SPREAD OF OKRA LEAF CURL VIRUS (OLCD) DISEASE IN CÔTE D'IVOIRE

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ABSTRACT

The spread of okra leaf curl virus disease (OLCD) in two different ecological areas of Côte d'Ivoire and the response of okra varieties and landrace cultivars to the disease were examined in 1986 and 1991. Much disease spread occurred at Bouaké in August, september and october. No linear relationship was found between the number of new infestations, vector population, temperature and rainfall. The Clemson Spineless variety developed the most severe OLCD symptoms at both sites. The ORS 958 variety and ORS 3193, ORS 3226, and 3212 hybrids were found to be susceptible to the disease at Adiopodoumé. At Bouaké, landrace cultivars Kotou 108, Klou 153 and the variety ORS 520 variety showed susceptibility to OLCD. The reaction of ORS 520 at both sites suggests that OLCD isolates at Adiopodoumé may differ biologically from that at Bouaké. The effects of OLCD on growth components, when infestation occurred 30 days after planting (DAP), were more important than those at 44 and 60 DAP.

Keywords : Vector, whitefly, *Bemisia tabaci,* okra leaf curl, geminivirus, Côte d'Ivoire.

RESUME

DEVELOPPEMENT DU VIRUS DE L'ENROULEMENT DU GOMBO (VEG) EN CÔTE D'IVOIRE

Une étude visant à examiner la propagation du virus de l'enroulement du gombo (VEG) dans deux régions écologiques de la Côte d'Ivoire a été conduite en 1986 et en 1991. Les résultats montrent une forte propagation de la maladie à Bouaké en août et au début des mois de septembre et d'octobre. Aucune relation entre le niveau d'infestation, la population de vecteur, la température et la pluviométrie n'a été observée. La variété Clemson Spineless a été la plus infectée quelque soit le site. La variété ORS 958 et les hybrides ORS 3193, ORS 3226 et ORS 3212 ont été sensibles au VEG à Adiopodoumé. A Bouaké, les cultivars Kotou 108 Klou 153 et la variété ORS 520 ont également développé les symptômes de la maladie. La réaction de la variété ORS 520 au niveau des deux sites suggère une variabilité biologique entre l'isolat du virus à Adiopodoumé et celui du virus à Bouaké. L'impact de la maladie sur les composantes de la croissance, lorsque l'infection a lieu 30 jours après la plantation (JAP), a été plus important que lorsqu'elle a lieu 44 et 60 JAP.

Mots clés : Vecteur, mouche blanche, *Bemisia tabaci*, enroulement du gombo, Côte d'Ivoire.

INTRODUCTION

Leaf curl disease of okra (OLCD) is caused by a geminivirus (Family *Geminiviridae* : Sub Group Begonovirus) transmitted by the whitefly *Bemisia tabaci*, Genn. The disease is potentially a serious cause of crop loss in okra production in Côte d'Ivoire. Characteristic symptoms are leaf curling, vein thickening and leaf area reduction. Severe symptoms such us stunting develop in susceptible varieties and may cause the death of the plant. Reported crop losses range from 30 to 100 % depending on the date of planting, the locality and variety (Lana, 1976 ; Fauquet and Thouvenel, 1987). Previous observations have shown that OLCD occurs in many regions of Côte d'Ivoire (Siemonsma, 1982 ; Fauquet and Thouvenel, 1987) and is more prominent in the savannah region of the North than in the forest region of the South (N'guessan *et al.*, 1992). The cultivation of many okra varieties and landrace cultivars is limited by the disease in some periods of the year. Dependence on insecticides for controlling the disease is not desirable because of high cost, associated hazard and also because okra is mostly produced for family consumption. Hence, the use of resistant varieties seems to be the best avenue for controlling the disease. In light of the increasing incidence of OLCD in okra in Côte d'Ivoire and its potential destructive nature, this study was conducted in order to assess the epidemiology and to determine the response of some okra varieties and some landrace cultivars to the disease.

MATERIALS AND METHODS

EXPERIMENTS CONDUCTED AT ADIOPODOUMÉ IN 1986

Based on preliminary observations, three okra varieties (ORS 520, ORS 958 and Clemson spineless (CS) from the ORSTOM Adiopodoumé Germplasm Collection and four of their hybrids m. CS vs f. ORS 958 (ORS 3193) ; m. CS vs f. ORS 520 (ORS 3226) ; m. ORS 520 vs f. CS (ORS 3212) and m. CS vs f. ORS 278 (ORS 3225) were planted in early April 1986 at the ORSTOM Experimental Farm (0.1 ha) of Adiopodoumé, 20 km west of Abidjan in the coastal forest region. Planting was laid out as a latin square comprising seven of each okra variety and was fully exposed to the direction of the prevailling wind (south-west) which is one of the major factors influencing the spread of whitefly-transmitted diseases at Adiopodoumé and elsewhere (Fargette, 1985 ; Fargette *et al.*, 1985 ; N'guessan *et al.*, 1992). Individual plot size was 4 x 4 m and comprised 6 rows of 6 plants each. Plants had 70 x 70 cm spacings. A gap of 1.5 m wide was maintained across the middle of the field to permit irrigation. For each okra variety, the number of plants showing typical OLCD symptoms was recorded at 30, 44 and 60 days after planting (DAP), and disease incidence was then expressed as a percentage of total stand. Whitefly populations were counted weekly, until 60 DAP, on all the leaves of the 28 marked plants of each okra variety (4 plants per individual plot). The cumulative average number of adults per plant of these counts was taken as the whitefly population that infected the crop during that particular period. The effect of OLCD on the number of leaves and fruits produced per plant was determined for each okra variety at 90 DAP.

EXPERIMENTS CONDUCTED AT BOUAKÉ IN 1991

Two fields experiments were carried out in 1991 at the IDESSA (Institut des Savanes) Experimental Farm in Bouaké, Côte d'Ivoire, 300 km North of Abidjan in the Savannah Region. Two okra varieties (ORS 520 and Clemson spineless), respectively, resistant and susceptible to OLCD (Hamon, 1988) and five landrace okra cultivars from the IDESSA germplasm collection (Soko 52, Ondo 116, Kotou 108, Yezi 90, Klou 153 were grown. The first field (0.12 ha) was planted on June 14th and field 2 on August 7th. Both experiments were laid out in a completely randomized block design. Each block was divided into three plots of 20 x 20 m size each, and comprising seven sub-plots, planted with one of the seven okra varieties and cultivars tested. Three to five seeds were sown per hill and thinned to one plant per hill three weeks after planting. Plants had 1 x 1 m spacing. Data collection for OLCD infection and whitefly population started 30 DAP and was done as previously, at Adiopodoumé. Meteorological data were obtained from the IDESSA Food Crop Department at Bouaké.

STATISTICAL ANALYSIS

Data pertaining to disease incidence on the okra varieties tested were analyzed using a one-way analysis of variance (SYSTAT 5.2 for Macintosh, copyright 1990-92). Tukey's least significant difference (LSD, P=0.05) was used to separate means. The Pearson linear correlation test was used to assess the relationship between disease incidence (% affected plants and whitefly populations) and environnemental factors (temperature and rainfall).

RESULTS

TEMPORAL PATTERN OF DISEASE PROGRESS

Figure 1a and 1b show the incidence of OLCD and whitefly population recorded for the two plantings at Bouaké station in 1991. The patterns of disease spread with time were similar to those of the cumulative whitefly population. Both were characterized by fluctuations corresponding to high and low disease incidences and whitefly numbers. However, the relationship between virus spread and vector population was not significant (table 1). Moreover, a relationship was found between virus spread and either temperature or rainfall. The highest disease incidence was recorded during late August for the first planting and early September for the second.

VARIETAL REACTION TO THE DISEASE

Table 2 presents disease incidence and whitefly populations recorded 60 DAP at Adiopodoumé in 1986 and at the two Bouaké fields in 1991. The responses of okra varieties and cultivars to OLCD infestation and to whitefly population differed at each site. The Clemson Spineless (CS) varieties, ORS 958 and ORS 3193, ORS 3226 and ORS 3212 hybrids were the most infected at Adiopodoumé, as compared to ORS 520 and ORS 3225 hybrids. At Bouaké, higher disease incidence was recorded for ORS 520 and CS varieties and Kotou 180 and Klou 153 cultivars than for Soko 52, Yezi 90 and Ondo 116 cultivars.

The whitefly population recorded for the different varieties did not follow the same pattern as far as disease incidence was concerned. The ORS 520 variety, with relatively low percentage of diseased plants, had the greatest vector population while disease incidence with low vector population was recorded on the CS variety and ORS 3193, ORS 3226 hybrids in Adiopodoumé. At Bouaké, whitefly infestation trends were similar to those at Adiopodoumé, except for the ORS 520 variety for which a high percentage of diseased plants was obtained for a great number of whitefly vectors. Larger numbers of whiteflies were also recorded for Soko 52 and Yezi 90 cultivars while for CS, Kotou 108 and Klou 153 cultivars the number of whiteflies was somewhat low.

DISEASE SPREAD AND EFFECT ON GROWTH COMPONENTS

Figure 2 shows the spread of OLCD with time and the dynamics of vector population recorded for ORS 520 varieties and CS at Adiopodoumé in 1986 and at Bouaké in 1991. There was a similarity between disease incidence with time and whitefly population at each site. Disease incidence on CS at Adiopodoumé was higher than that recorded at Bouaké. The incidence of OLCD in CS at Adiopodoumé was higher than on ORS 520, although the number of whiteflies was less. At Bouaké, there was no significant difference in incidence on the two varieties. Incidence on the CS variety at Adiopodoumé was

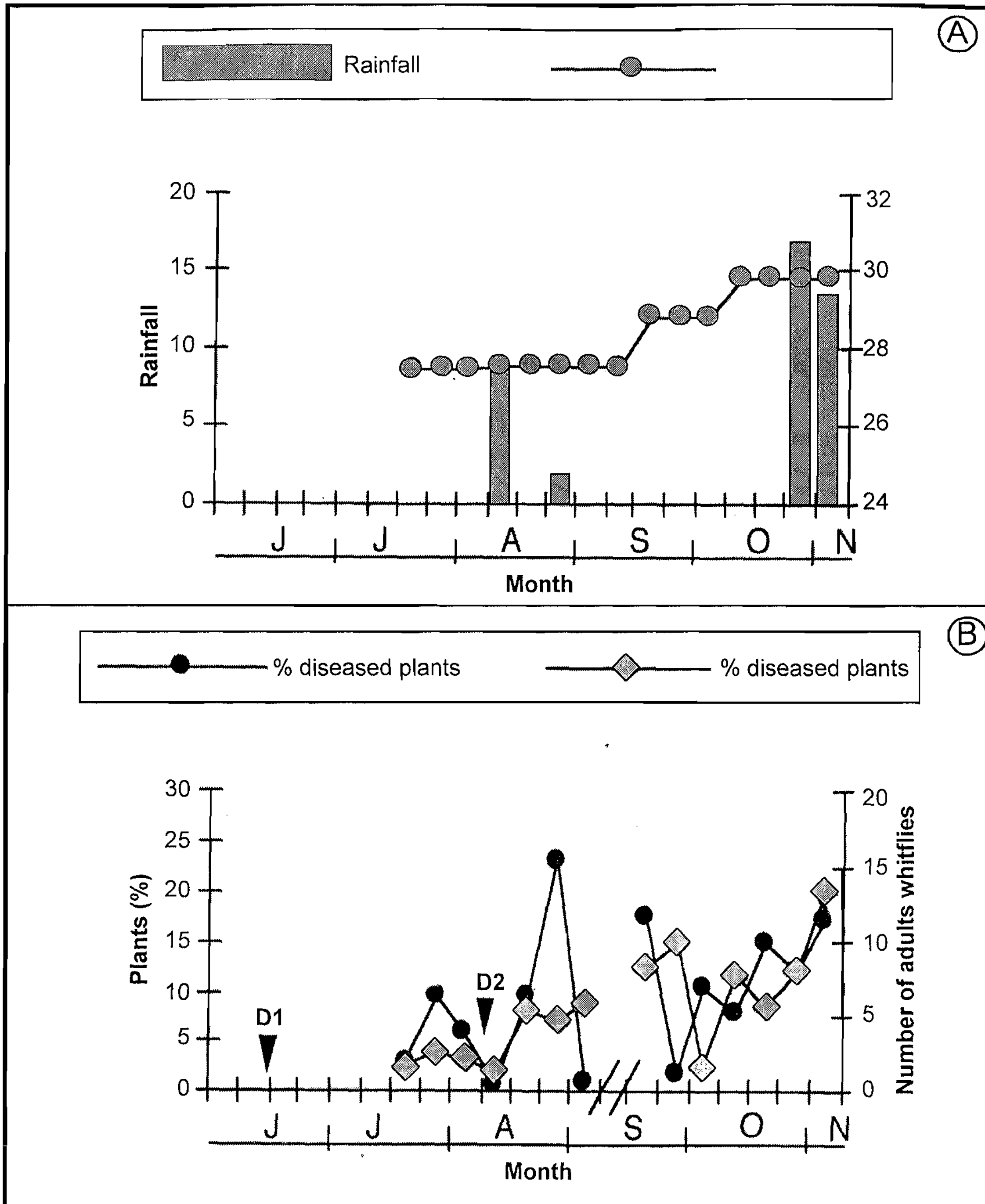

Figure 1 : Temporal spread of OLCD and whitefly population in two successive fields and meteorological data at Bouaké in 1991.
D1 and D2 are respectively planting of field 1 and field 2.

Evolution temporelle de la maladie virale de l'enroulement du gombo (OLCD) et de la population de mouches blanches sur deux champs à Bouaké et données météorologiques.
D1 et D2 sont respectivement la date de plantation du champ 1 et champ 2.

Table 1 : Level of correlation (R^2) between disease incidence, whitefly population, mean temperature and rainfall.

Niveau de correlation (R^2) entre la maladie, la population de mouches blanches, la température moyenne et la pluviométrie.

	Parameters level of correlation					
	Field 1			Field 2		
	Disease	Whitefly	T (°C)	Disease	Whitefly	T (°C)
Number of Withefly	0.11 (1.00)			0.003 (1.00)		
T (°C)	0.05 (1.00)	0.18 (1.00)		0.11 (1.00)	0.20 (0)	
Rainfall (mm)	0.03 (1.00)	0.39 (0.79)	0.18 (1.00)	0.09 (1.00)	0.8 (1.00)	0.29 (1.00)

* numbers in parentheses are probabilities at p = 0.05.

Table 2 : Disease incidence and mean cumulative number of whiteflies recorded 60 DAP at Adiopodoumé in 1986 and at Bouaké in 1991.

Incidence de la maladie et nombre moyen cumulé de mouches blanches enregistrés 60 JAP à Adiopodoumé en 1986 et à Bouaké en 1991.

Varieties	Disease incidence and cumulative number of whiteflies							
	Adiopodoumé		Bouaké					
	Disease incidence (%)	Number of adult whiteflies	Disease incidence (%)			Number of adult whiteflies		
			Field 1	Field 2	Mean	Field 1	Field 2	Mean
CS	86 a*	42 b	66 a	100 a	83 a	4 b	6a	5a
ORS 3193	76 a	53 b	-	-	-	-	-	-
ORS 958	71 a	89 a	-	-	-	-	-	-
ORS 3212	66 a	46 b	-	-	-	-	-	-
ORS 3226	60 a	47 1b	-	-	-	-	-	-
ORS 520	47 b	104 a	52 a	82 a	67 a	6 a	13 b	10 ab
ORS 3225	39 b	33 b	-	-	-	-	-	-
Kotou 108	-	-	47 ab	88 a	68 a	4 a	15 b	10 ab
Soko 52	-	-	28 b	59 b	43 b	6 a	18 a	12 a
Ondo 116	-	-	17 b	43 b	30 b	4 a	15 b	9 ab
Klou 153	-	-	23 b	88 a	55 a	3 b	8 c	6 b
Yezi 90	-	-	10 b	42 b	26 b	6 a	13 b	9 ab

* number, followed by the same letter are not significantly different ;
- = not tested.

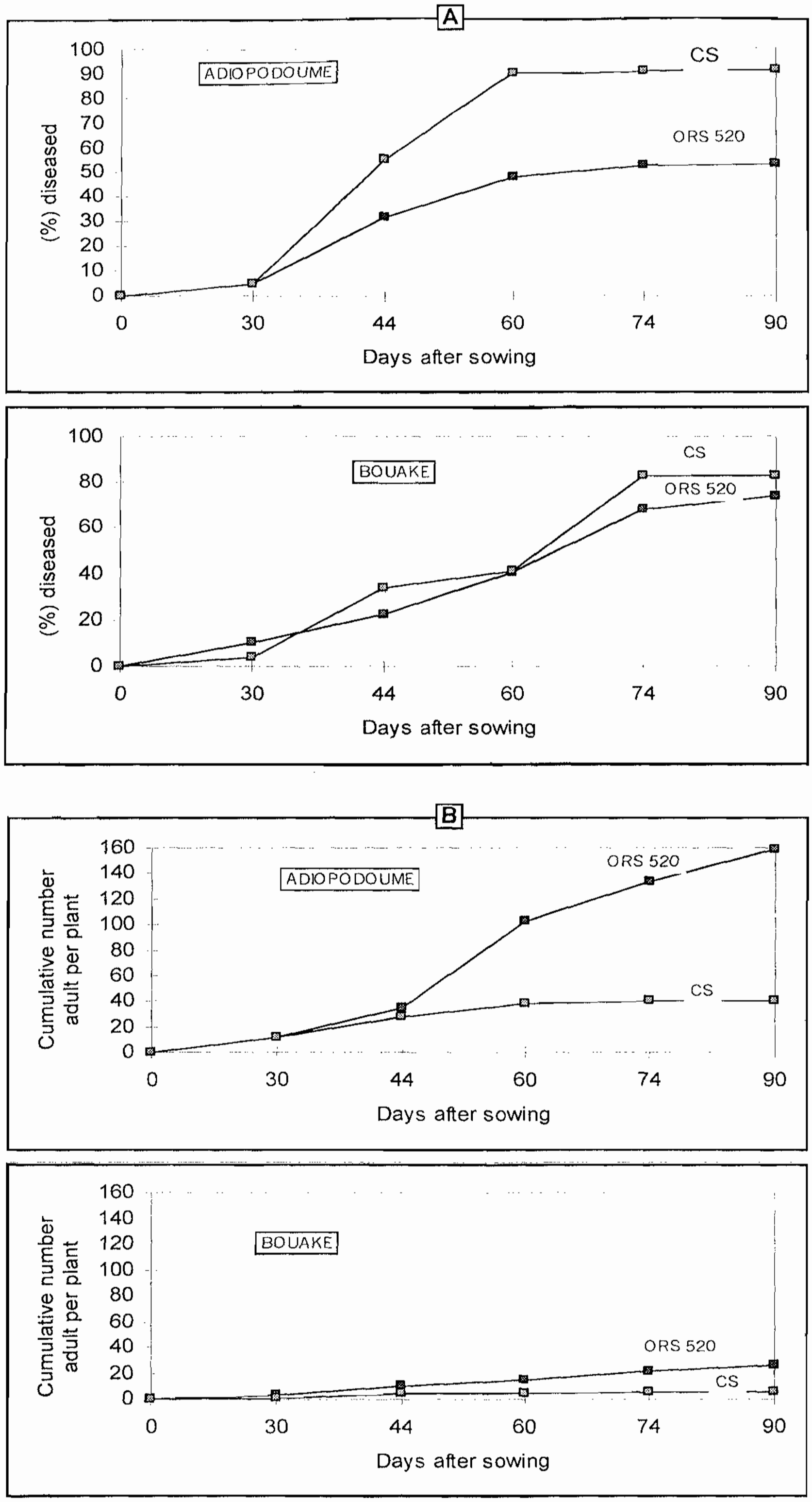

Figure 2 : Disease progress curve of OLCD and vector whitefly population at Adiopodoumé and at Bouaké.
(A = disease ; B = cumulative mean whitefly number per plant).

Courbe d'évolution de la maladie et de la population de mouche blanche vecteur, à Adiopodoumé et à Bouaké.
(A= maladie ; B = moyenne cumulée de mouches blanches par plante).

similar to that at Bouaké, although this variety was slightly more infected at Adiopodoumé than at Bouaké. In contrast the incidence of OLCD on the ORS 520 variety was higher at Bouaké than at Adiopodoumé. There was no significant difference in infection between the two varieties at Bouaké.

Okra leaf curl disease reduced plant height, number of leaves and fruits of the CS variety when the disease occurred 30, 44 and 60 DAP, whereas, with ORS 520, no reduction in these parameters was observed (table 3). The reduction in the parameters for the CS variety was greater for plants affected by OLCD 30 DAP than for plants affected later.

by Vetten and Allen (1983) and Anzola and Lastra (1985) who found a clear relationship between the spread of other whitefly-borne diseases and vector population. The lack of relationship between disease and vector population noted in our study, may be due to many factors of which the vector biotype and the time spent by the vector between feeding and symptoms appearance.

None of the okra varieties tested was immune to infestation. Plants from each variety developed typical OLCD symptoms. However, there was a significant difference between infectivity, response to infestation and vector population at both sites. Some varieties showed high disease incidence and severe leaf curl symptoms whereas others had a relatively low incidence and mild OLCD symptoms. The response of okra cultivars to the disease at Adiopodoumé showed, based on symptom expressions and yield loss data that CS and ORS 520 varieties were susceptible to OLCD. ORS 3193, ORS 3226 and 3212 hybrids were also susceptible to the disease. At Bouaké, in addition to CS variety, Kotou 108 and Klou 153 cultivars showed a susceptible reaction to OLCD.

Table 3 : Effect of Okra leaf curl disease (OLCD) on mean plant height, number of leaves and fruits produced by affected plants at different times after planting.

Impact du virus de l'enroulement du gombo (VEG) sur la hauteur, le nombre moyen de feuilles et de fruits produits par les plants infectés à différentes dates après plantation.

	Effect of OLCD on parameters					
	Height+ (cm)	Number of leaves	Number of fruits	Height+ (cm)	Number of leaves	Number of fruits
30P	163 a*	31 a	9 a	38 cd	9 c	1 c
44	161 a	30 a	11 a	47 c	12 bc	4 b
60	160 a	32 a	11 a	63 ab	14 b	5 b
Healthy	162 a	32 a	11 a	67 a	18 a	9 a

+ numbers are mean per plant ;
* numbers followed by the same letter are not significantly different at P = 0.05.

DISCUSSION AND CONCLUSION

Temporal patterns of OLCD showed that disease incidence was high during August and October months in plantings at Bouaké. In addition, no relationship was found between changes in disease incidence and whitefly population. These results did not agree with those reported

These results support earlier reports indicating that OLCD was a serious constraint to the cultivation of some okra varieties in West Africa (Hamon, 1988 ; Atiri and Ibidapo, 1989 ; Atiri and Fayoyin, 1989 ; N'guessan *et al.*, 1992). As for ORS 520, infestation rates differed between the two sites. Relatively low disease incidence was recorded with this variety at Adiopodoumé when compared to the susceptible varieties, whereas at Bouaké, it was one of most susceptible. This result suggests that OLCD isolates at Bouaké may differ from those at Adiopodoumé. Further investigations are needed for a better understanding of the response of okra cultivars to OLCD in different environnements in Côte d'Ivoire.

The vector population recorded at Adiopodoumé did not follow the same temporal patterns as the disease incidence did. The ORS 520 variety, with a low percentage of diseased-plants, had the highest vector population, while high disease incidence with low vector population was recorded for the CS variety and ORS 3193, ORS 3226 and ORS 3212 hybrids. These results indicate that, for these varieties, symptoms expression and vector population were not related. This was not so for ORS 958 and 3225 varieties at Adiopodoumé and ORS 520 and Kotou 108 varieties at Bouaké which showed disease incidence to be controlled by vector population. It has been reported, in many cases, that insects preference for a host-plant is often related to the botanical or agronomical traits of the plant (Iheagwan, 1980 ; Vetten and Allen, 1983 ; Woodhead and Padgham, 1988). The present study does not explain how the different varieties affect the feeding behaviour of the whitefly vector. However, differences observed in the number and shape of leaves and the nutrient status of the different okra varieties are found to influence the feeding behaviour of the whitefly vector and its efficiency in acquiring and transmitting the virus.

Although OLCD has been reported as the most important viral disease which limits the cultivation of many okra varieties and landrace in Côte d'Ivoire, little attention has been devoted to it. In addition, little is known about the reaction of the landraces most widely grown by the farmers. More than 600 okra accessions, collected throughout Côte d'Ivoire, are being studied and screened for a number of agronomic characters and resistance to major pests and disease by the CNRA Vegetable Crop Improvement Programme. Information obtained from the present study represents an important step towards achieving the objectives of this programme.

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