

1 **Genetic Variability of Sugarcane Clones as Affected by Endemic**
2 **Diseases at One-Row Screening Stage in Ferké, Northern Ivory**
3 **Coast**

4 **Abstract**

5 Z¹ out over 2 seasons (2016-18) as plant and first ratoon cane ^{at} Ferké 1 experimental
6 station under full covering sprinkler irrigation in northern Ivory Coast. Treatments
7 were composed of 863 sugarcane genotypes split into 39 families planted at single
8 row density. Planting was done per genotype ⁱⁿ and per row ^s of 3 m long depending on
9 families, without replication and compared to the check variety SP70/1006. That ^{check} one
10 was replicated ~~several times~~ ^{five} every 5 rows to ease ^{comparison with the} agronomic observations of clones in
11 ~~comparison with that check variety~~. Phytosanitary observations regarding the three
12 endemic diseases made at the age of 5 months were subjected to a series of
13 multivariate analyses. It ~~came out from~~ ^{showed} the study that most relevant diseases
14 determining the diversity of susceptible sugarcane genotypes were, in descending
15 order, pokkah boeng, smut and leaf scald. ^{The} Dendrogram ^{deduced} resulted from cluster analysis
16 showed that infected genotypes were split into ^{six} 6 groups. Cluster G5 was the most
17 prolific of infected genotypes with 286 clones (33 %) split into 36 families over 39
18 (92 %). It was followed by clusters G6 and G1 with 125 and 93 infected genotypes
19 split into 29 and 28 families, respectively. Clusters G2, G3 and G4 were the less
20 prolific ones, with 42, 52 and 56 infected genotypes split into 14, 23 and 21 families,
21 respectively. Clusters G1 and G2 were much more associated with genotypes
22 susceptible to smut and pokkah boeng but also with genotypes moderately susceptible
23 to pokkah boeng. Clusters G3 and G4 were rather associated with genotypes
24 susceptible or highly susceptible to leaf scald. In contrast, clusters G0, G5 and G6
25 were related to disease free, resistant or moderately resistant genotypes and which
26 crosses or families would therefore be recommended for Ferké agro-ecology.

27 Key words: leaf scald, smut, pokkah boeng, susceptibility, resistance, agro-ecology,
28 multivariate analysis.

29 **1. Introduction**

1 - 10 write in words. not figures,

Sugarcane is a major commercial crop grown in tropical and subtropical regions of the world, including West and Central Africa. During the last 100 years, many sugarcane producing countries such as Mauritius, Reunion Island, Java, New Guinea, India and South Africa, have experienced epidemics of various diseases like red rot, smut, wilt, rust leaf scald gummosis and yellow leaf (Viswanathan and Rao, 2011; Viswanathan et al, 2011; Singh *et al*, 2011). The damage caused during each epidemic would vary depending on the nature of disease and spread of affected varieties. Number of sugarcane varieties were replaced because of their breakdown to new diseases or to new pathogenic strains. Propagation of sugarcane through vegetative cuttings enhances spread of diseases through planting materials. Primary transmission of diseases by seed canes causes a serious threat to sugarcane growth and yields. Therefore, disease resistant varieties play a key role in controlling numerous biotic constraints in sugarcane and several varieties were developed to manage diseases in the past. In parallel, different agronomic practices and physical methods like hot water therapy are being effectively used to control diseases ^{transmission} ~~propagation~~ in sugarcane. More recently, propagation of sugarcane through tissue culture is being used in some advanced countries to produce virus, phytoplasma and bacteria disease-free planting materials. Use of disease resistant or tolerant varieties along with healthy seed nursery programs would form the basis to successfully manage diseases in sugarcane. Across West and Central Africa, smut, leaf scald and pokkah boeng used to be considered as endemic diseases in sugarcane. The first two (smut and leaf scald) were revealed economically important compared to pokkah boeng. Still, severe symptoms of pokkah boeng with top-rotting damages were often observed on highly susceptible cane genotypes which needed to be identified and eliminated in the crop breeding process. That's why the three diseases used to be considered among criteria of importance in variety selection of sugarcane carried out in Ivory Coast (Zadi *et al*, 2016; Péné *et al*, 2016). Managing these endemic diseases through variety selection in the targeted African region is of crucial importance regarding the context of growing interest for crop improvement based on cross hybridization and selection of genotypes at early stages where numerous plant materials investigated are often highly susceptible (Béhou *et al*, 2018). ^{Having} ~~Better~~ knowledge of crosses responsible for susceptible or highly susceptible genotypes would help in the choice of parental material for location-oriented hybridizations.

^{aim of the work} The study aimed to characterize the genetic variability of susceptible sugarcane genotypes to three endemic diseases at one-row screening stage, namely smut, leaf scald and Pokkah Boeng.

63 2. Material and methods

64 Site characteristics

65 The study was carried out at Ferké 1 experimental station in northern Ivory Coast ($9^{\circ}20' -$
66 $9^{\circ}60' \text{ N}$, $5^{\circ}22' - 5^{\circ}40' \text{ O}$, 325 m). Prevailing climate is tropical dry with two seasons: one is
67 dry which occurs from early November to April and the other, wet, from May to late October.
68 The dry season is marked by a northern and warm trade wind (*Harmattan*) taking place from
69 mid-November to late January. Rainfall pattern is unimodal and centered over August and
70 September which cumulate almost half of annual average rainfall (1 200 mm) with an
71 average daily temperature of 27°C , maximum and minimum values yielding 32.5 and 21°C ,
72 respectively. Irrigation water requirements for sugarcane growth and yield performance to
73 about 650-700 mm/yr (Konan *et al.*, 2017a,b; Péné *et al.*, 2013). Main soil units (ferralsol or
74 hydromorphic type) are characterized by shallow to moderate depths (30-80 cm) with sand-
75 clay as predominant soil texture where the experiment was located.

76 Sugarcane crop material

77 The crop material investigated which comprised 863 sugarcane genotypes, was grown over
78 two years as plant crop and first ratoon at one-row screening stage. All clones were planted
79 following families and compared to a check commercial variety (SP70-1006). Genotypes
80 derived from the second generation of sugarcane hybrid seeds ^{were} provided in November 2015 by
81 Reunion Island sugarcane breeding center (eRcane). They resulted from bi-parental crosses of
82 commercial or elite varieties of diversified origins (Reunion, Brazil, Australia, Sudan,
83 Florida, Colombia, South Africa, etc.).

84 Endemic diseases symptoms

85 Pokkah boeng is a fungus ~~top rotting~~ ⁿⁱ of minor economic importance caused by *Fusarium*
86 *moliforme*. Injury varies from slight chlorosis and splitting of the base of young unfolding
87 leaves to top rotting, which may kill the growing point. While common in certain susceptible
88 varieties during warm and rainy weather, it is seldom of commercial importance.

89 Leaf scald, caused by a bacterium (*Xanthomonas albilineans*), is considered among
90 sugarcane major diseases and therefore of commercial importance. It is primarily a vascular
91 disease with streaks produced on cane leaves. Sometimes, instead of definite stripes, the
92 entire shoot is chlorotic to nearly white. Diseased plants have a characteristic stunted

need of
susceptible
& resistant
checks for
sel

if relevant
take to
introduction

93 appearance and the terminal whorl of leaves curves inward at the tips, which are often dried
 94 or withered (Rott, 1995). Sprouting of the lateral buds beginning at the base of stalk is
 95 characteristic and may occur when there is no apparent injury to the top. In the acute stage,
 96 some shoots or the entire stool may sudden^{ly} wilt and die. The disease causes marked
 97 reductions in growth, tillering and ratooning ability of susceptible varieties. It is highly
 98 infectious and spreads through infected seed cane, knife cuts and probably by other means of
 99 physical contact.

not
necessary
here.

100 Smut, caused by a fungus namely *Ustilago scitaminea* is characterized by the production
 101 from the growing point of a long whiplike shoot. Smut spores are scattered when the
 102 membrane covering this shoot bursts. Infection takes place through seed pieces and through
 103 axillary buds of the growing plant. Germination of buds from infected cuttings may be
 104 seriously reduced, the plant is stunted and ratooning ability is weakened.

105 Experimental design

106 The experimental design used at one-row screening stage was a randomized complete block
 107 comprising 863 clones, each being planted in a single-row plot of 3 m long without
 108 replication apart from the check variety. That one was replicated many times (173) every 5
 109 rows of clones subjected to visual screening. Clones split into 39 families (or crosses) as well
 110 as the check variety were planted separately in single row plots with 1.5 m between-row
 111 spacing (4.5 m²/plot) in November 2016 following 11 blocks of 7 m wide and 30 m long with
 112 3 m spacing. Within each block, there was a 1 m spacing between adjacent clones to allow
 113 distinction of individual clones during disease ratings, growth vigor evaluation and selection.
 114 To prevent edge effects the field trial was surrounded by a buffer zone of 3 m wide and 30 m
 115 long planted with a commercial variety (R579).

design,
↑

116 Epidemic disease observations

117 Symptoms of Smut, leaf scald and Pokkah Boeng as epidemic diseases in West and Central
 118 Africa were observed on sugarcane genotypes at the age of 5 months. Their causal agents are
 119 respectively *Ustilago scitaminea* (or *Sporisorium scitamineum*), *Xanthomonas albilineans*
 120 and *Fusarium moniliforme* ^{SP.} They all are air borne diseases, with leaf scald as a bacteriosis
 121 and the other as fungus. Smut and leaf scald were known as economically important diseases
 122 compared to Pokkah Boeng. Disease ratings were based on percentage of cane shoots or
 123 stools infected by fungus or leaf scald.

Where the disease based
on natural infection or
inoculated??
Where these
not for?

124 The susceptibility scale of smut was provided by Rao et al (1996) as follows:

- 125 • Free of symptom: 0 %;
- 126 • Resistant: 0.1 - 5 %;
- 127 • Moderately resistant: 5.1 - 15 %;
- 128 • Moderately susceptible: 15.1 - 30 %;
- 129 • Susceptible: > 30 %.

130 That of Pokkah Boeng was provided by Gulya *et al* (1980) as follows:

- 131 • Free of symptom: 0 %;
- 132 • Resistant: 0.1 - 1 %;
- 133 • Moderately resistant: 1.1 - 10 %;
- 134 • Moderately susceptible: 10.1 - 25 %;
- 135 • Susceptible: 25.1 - 50 %;
- 136 • Very susceptible: 50.1 - 100 %.

Write in essay
form NOT bullets.

137 The leaf scald susceptibility scale is the following:

- 138 • Free of symptom: 0 %;
- 139 • Susceptible: 0.1 - 10 %;
- 140 • Very susceptible: 10 - 100 %

141 Statistical analysis

142 *Data processing was conducted using* Excel 2013, Statistica 7.1 and R 2.2 software packages ~~were used for data processing~~, which
143 was based on clone phenotypic traits observed in the experiment. To do so, data were firstly
144 recorded as a database and processed on Excel following a dynamic crossed table. Percentage
145 of disease infestations and qualitative assessment of infestations (ratings) were used in data
146 processing. A series of 3 multivariate analyses using R software, i.e. principal component
147 analysis (PCA), cluster analysis (CA) and corresponding factor analysis (CFA), were made.
148 The data were computed in application of Mahalanobis D² statistics among all possible
149 combinations of genotypes grouped into different clusters following canonical root method
150 described by Rao (1952).

151 3. Results

152 Estimates of disease free or infected clones in plant and first ratoon cane