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A Survey of Diseases on Sugarcane Germplasm in Three Regions of Cameroon

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Abstract

Sugarcane production by smallholder farmers in the recent past has been adversely hampered by biotic constraints particularly diseases. This study was carried out to evaluate the disease situation of sugarcane in three regions of Cameroon. A survey was carried out in 66 villages chosen based on subsistence production for local consumption. Representative cane samples of the landraces identified included SMU58, SBK36, SNC16, NBfPc48 and NBfAg53. Representative samples were collected and grown in an experimental field in the Department of Plant Science in the University of Buea. The canes were ready for observation for disease symptoms after 11 months of planting. Disease symptoms were observed both in the experimental and on farmers' fields and described. The disease incidence was calculated based on the different landraces, regions and symptom types. The incidences of disease symptoms varied among the different, landraces, regions and symptom types. The disease incidence ranged from 18.1 to 43.5%. Diseases incidence observed during the survey indicated that there were less infected canes per stand in the South West than in the other two regions. West region had the highest incidence. SBK36 recorded the highest incidence (33.3%) while NBFPc48 recorded the least. These foliar symptoms ranged from eye spot disease to leaf roll disease, with mosaic symptom recording the highest incidence. To maximize production, there is need to monitor the disease situation. Integrated management plan is of significant to reduce the incidence of disease in order to increase yield.

Keywords: *Survey, Diseases, Sugarcane landraces, Regions, Cameroon*

1. Introduction:

Sugarcane, (*Saccharum officinarum* L.) belongs to the Gramineae (Syn. Poaceae). It is propagated by stem cuttings [1] and occupies an area of 20.42 million hectares worldwide. The production is about 2.165 million tons and accounting for more than 50% demand of sugar over the world [2].

Sugarcane is the principal raw material for the sugar industry, being the source of the most widely produced and consumed sugar in the world. One of the biproducts of sugarcane production is bioethanol which can be used as fuel in place of gasoline. Seventy percent of the world's sugar comes from sugarcanes. Africa has been the least world producer of sugarcane, with yields lower than the worlds mean [3]. In many west and central African countries, production started rising only after the 1970's when there was an effort to meet up with domestic sugar needs [4].

In Cameroon, sugarcane is produced in home gardens, where it is chewed as a snack. Commercial production goes on in plantations owned by sugar processing factories (SOSUCAM). These plantations are found in the Haute-Sanaga Division (Nkoteng and Mbandjock) where about 130,000t of sugar per year is produced [5] [6]. This is supplemented by contract Cane Growers (CG). Cameroon ranks 51 in the world amongst the sugarcane producing countries and her production quantities has dropped from 1,450,000 tons in 2009 to 1.200.000 tons in 2013.This decrease in production continues due to the need for land for the construction of houses for the increasing population and the introduction of other cash crops [8].

The sustainable and consistent production of sugarcane by smallholder farmers in the recent past has been adversely hampered by biotic constraints particularly diseases. It is being affected by several biotic factors like fungi, bacteria, viruses and phytoplasma causing reduction in production and productivity according to

its severity [8]. Many diseases of sugarcane have been reported from different parts of the world. Smut, red rot, leave blast, Sugarcane mosaic, ratoon stunting disease, sugarcane wilt disease among other diseases are affecting sugarcane in some African countries [9]. In Mbanjock and Nkoteng, Cameroon, sugarcane orange rust disease has been observed [10]. Yield losses can be significant under endemic conditions if disease establishes early in the growing season and continues to build up until harvest. Diseases have been implicated as one of the causal factors of genetic erosion of sugarcane in Western Cameroon. However, information on the different diseases associated with sugarcanes in Western Cameroon has been scarce.

This study was therefore aimed at surveying sugarcane fields in three regions of Cameroon, to evaluate the presence of disease symptoms. The present study consisted of a survey of sugar cane germplasm of some prospective local landraces in the field and on an experimental plot in order to access the different diseases affecting sugarcane production. The identification of these diseases poses serious challenges and calls for effective management measures.

2. Materials and Methods:

2.1 Study site

The study was carried out in three regions located in two agro-ecological zone (AEZ) of Cameroon. Specifically, in the humid forest with monomodal rain fall zone in the South West Region and the western high plateau zones in West and Northwest Regions of Cameroon. The study site spanned from Longitude $8^0$13 to $11^0$14 E and Latitude $3^0$48 and $6^0$11 N. This study zones have a temperature which ranges from 22 ^{0}C to 32^{0}C and the relative humidity is normal around 80%. This area includes forest and plantations. This zone has dark fertile volcanic soil. The soils are classified as ferralsols and occur in association with alisols, nitisols and acrisols which have clay accumulation horizons but low base saturation. Main food crops for these zones are oil palm (*Elaeis guineensis*), maize (*Zea mays*), cocoyams (*Xanthosoma sagittifolium*), plantains (*Musa spp.*), rice (*Oryza sativum*), okra (*Abelmoschus esculentus*), potatoes (*Ipomoea batatas L.* and *Solanum tuberosum L.)*, groundnut (Arachis hypogeal), beans (*Phaseolus sp*, cassava (*Manihot esculenta* Crantz), tomato (*Solanum lycopersicum* L.) and yams (*Dioscorea sp*).

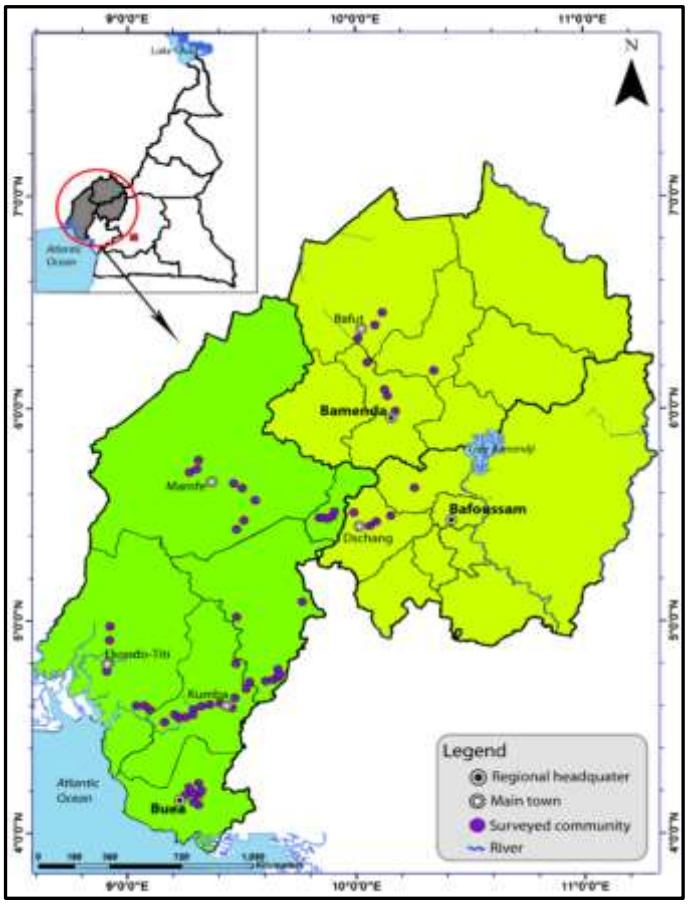

Fig 1: Survey villages for disease incidence in South West, North West and West Regions of Cameroon.

2.2 Survey sampling

Based on earlier reconnaissance surveys and altitudinal distribution, 66 villages were targeted for the survey from three regions in Cameroon namely the Southwest, West and Northwest Regions (Fig 1). The villages surveyed were: Upper farms, Lower farms, Ashum, Bagem, Bakebe, Barombi kang, Belluah, Besongabang, Bokova, Bole, Bolifamba, Bonakanda, Deponda, Bisingi, Diongo, Ebonji Tombel, Egbekaw, Ekona, Ekondo Titi, Ekumbe Bonji, Etam, Eyang, Faichang,Funge, Kake, Kombone Bonji, Konye, Kumbone Bakundo, Lewoh, Lobe Estate, Mabanda, Mabonji Bakundu, Mammu, Mbinjong, Menji, Mile 19 Tombel, Molyko, Muea, Mundemba, Musung camp, Nake, Nchang, Ndungated, Nganjo, Bekora, Ngap, Ngongo, Seat of wisdom, Teke, Tombel, Baleveng, Dchang, Fongo tongo, Foto, Johnny Baleng, Mbouda, Toula Ndizong, Njinteh Bafut, Aghiati, Obang, Befang, Wey, Wum and Nkwen. The villages were chosen based on subsistence production for local consumption. These villages have been a subject of previous sugarcane germplasm collection and ethnobotanical investigation. A village was targeted if it had at least a field with ten stools.

2.2.1. Experimental field survey

Representative cane samples of five sugarcane landraces namely SMU58, SBK36, SNC16, NBfPc48 and NBfAg53 identified by the farmers during recognizance field survey were collected and brought to the University of Buea. From this, 2-nodal cuttings of the field samples were raised in polythene bags filled with a potting mixture of top soil and poultry manure (3: 1 v/v). The setts were planted 15cm deep spaced 30cm apart. 0.5kg of Mocap10G was applied to the nursery to keep away insects and rodents. The nursery was regularly irrigated every evening. The field samples in the nursery were used to establish a field gene bank of the landraces. The landraces from the nursery were planted out in a completely randomized design in the experimental plot of the Department of Botany and Plant Physiology at the University of Buea, during the 2013/2014 cropping season. Each plot had three rows of 20m length spaced 1m apart with intra-row spacing of 50cm. The compound fertilizer N.P.K (20.10.10.) was used in a four equal - split application at a rate of 230kg ha^{-1}. The first split was applied as top dressing before planting and the rest at three months intervals. The field was irrigated as needed in the first months of planting before the rains become steady. Weed was controlled manually by hoeing and earthling up. Detrashing of canes was monthly after the first three months of planting. Insects control was by the use of an insecticide Cypermethrine (Plantac 20WP), applied in the field at a rate of 4kg ai ha^{-1}. Birds and human control were done by use of scarecrows. Sampling for disease symptoms was done when the canes were fully mature at 11 months after planting. Five stools were randomly selected from the five different landraces.

2.2.2 Field sampling

Farmers' Fields sampling was conducted at the early months of the rainy season (March, 2014). In each village, five fields were sampled randomly and, in each field, five stools were randomly selected for sampling for disease symptoms.

The total number of sugarcanes per stand and the number of infected plants per stand and symptom types both in the experimental and farmers' fields were recorded in a field note book. Photographs of symptom types were taken and disease symptoms observed were described. The mean infection in each landrace and in each region and the incidence of symptom types were analyzed using simple mathematic means. The disease incidence, which is the number or proportion of plant units that are diseased (the number or proportion of plants, leaves and stems that showed any symptoms) in relation to the total number of units examined [11] was calculated.
The disease incidence was calculated as follows;

$$I = \frac{\text{NO. Of plants with infection}}{\text{No.of plants observed}} \times 100 \text{----------} \quad [1]$$

Where I= incidence.

The incidence of symptom types was calculated as follows;

$$I = \frac{\text{NO. Of symptom type}}{\text{Total No.of symptoms observed}} \times 100 \text{---------- [2]}$$

Where I= incidence.

3. Results

3.1. Disease occurrence in experimental field

In the experimental field, SBK36 recorded the highest incidence (33.3%) while NBFPc48 recorded the least (Table 1).

Table 1: Incidence of diseased canes in experimental field

Landrace	Mean No. of canes per stand	Mean No. of diseased canes	Incidence (%)
NBFAg53	12	03	16.7
NBFPc48	14	02	14.3
SBK36	09	03	33.3
SMU58	11	03	27.3
SNC16	13	02	15.4

The incidences of disease symptom varied among the different regions (Table 2). The disease incidence ranged from 18.1 to 43.5%. Diseases incidence observed during the survey indicated that there were less infected canes per stand in the South West than in the other two regions. West region had the highest incidence.

Table 2: Incidence of diseased canes in farmers' fields in three regions of Cameroon

Region*	No. of villages sampled	Mean No. of canes per stand	Mean No. of diseased canes	Incidence (%)
NWR	10	09	03	33.3
SWR	47	08	02	25
WR	09	11	03	27.3
Total	66	28	08	28.5

*NW=Northwest region, SWR=Southwest region, WR=West region

Different disease symptoms were observed in all the fields surveyed. Many foliar symptoms were observed in the study as shown in Fig 2.1. These foliar symptoms ranged from eye spot disease to leaf roll disease.

Eye spot symptoms were characterized by reddish – brown elliptical lesion (0.5 to 0.4 mm long, 0.5 to 2 mm wide) with yellowish – brown margins. Reddish brown to yellowish brown runners extend upward from individual lesions towards the leaf apex. The entire leaf can become necrotic due to the combine effect of the spot and runner formation (2.1a).

White leaf diseases **s**ymptoms were characterized by cream line parallel to the midrib and could be seen from either side of the blade. The stripe had wide ranges, from narrow pin stripe to as broad as the leaf. A

mottled pattern of normal or light green dot, spot, streak or patch islands developed on a white background, varying in size and shape (2.1b).

Rust disease symptoms observed were common rust, small, elongated yellowish spots which are visible on both the surfaces. These spots sometimes turn red-brown to brown in colour. A narrow, pale yellow-green halo develops around the lesions. Severe symptoms were numerous lesions on individual leaves giving them an overall brown or rusty appearance (2.1c).

Leaf scorch symptoms appeared on the leaf blade as small red to dark brown spots characteristically surrounded by a yellow halo. The spots sometimes turned reddish and elongated with yellow margin. The lesions center was observed to be necrotic with minute blackish dots on the upper leaf surface (2.1d).

Leaf scald symptoms were characterized by cream to yellow stripes starting at the tip or the margin of the leaf. A typical white pencil-line stripe (1-2 mm wide) ran from several centimeters to almost the entire length of the leaf. A red pencil line was observed in the middle of the stripe. Chlorosis of leaves was also observed and was accompanied by an inward curling of the leaves (scalding) (2.1e).

Yellow spot had yellow lesions observed on the leaf blade. The lesions were irregular in shape and vary in colour from yellow, brick red, red brown or brown black (2.1f).

For mosaic disease, the most distinctive symptom was a pattern of contrasting shades of green. Islands of normal green on a background of paler green or yellowish chlorotic areas were seen on the leaf blade. Generally, the chlorotic areas were diffused. The symptoms were sometimes accompanied by varying degrees of leaf reddening or necrosis. Chlorotic areas were most evident at the base of the leaf (2.1g).

The symptom of the smut disease was the production of a black whip- like structure from the central core of the meristematic tissue. This appendage was irregularly curved when it grows more. A thin, white and papery membrane covered the whips when young.

Fig 2.1: Field disease symptoms of sugarcane leaves: (a) Eye spot disease b) White leaf disease (c) Rust disease (d) Leaf scorch diseases, (e) Leaf scald disease, (f) Yellow leaf Spot (g) Mosiac disease.

Stems were also infested by pest as shown in Fig 2.2a, ranging from 'peel off' bark appearance to wilt. Sugarcane stem borer infestation was observed in the fields. Pests were observed to destroy the young shoots. The central whorl of the leaves in the stem (growing point) was cut by the caterpillars which result in wilting and drying (dead heart). These plants though do not develop further but the dormant buds sprout and give side-shoots. The destruction was restricted only to a few internodes (2.2b). The characteristic and diagnostic symptom of stem rot disease was the presence of reddish discoloured patches or lesions interspersed with white horizontal patches on the internal tissue and dark colour was observed in the internal tissues, resulting in longitudinal pith cavities (2.2c). The disease symptoms for wilt appeared displays conspicuous stunting and unthrift appearance, followed by yellowing and / or withering of crown leaves on splitting up on the affected canes, the diffused purple or muddy red colour was seen as conical patches on each node just above the growth ring (2.2d).

2.2: Field disease symptoms on sugarcane stalks: **(**a) Stem borer damage (b) 'Peel off' bark appearance, (c) Stem rot disease, (d) Wilt disease.

Table 3. Incidence of disease symptom types on Sugarcane in three Regions of Cameroon

Symptom type	Regions		
	Southwest	Northwest	West
Red rot disease	28.0	37.8*	34.1
Wilt diseases	34.7	18.1	42.2
Smut disease	27.5	35.0	27.5
Rust disease	29.4	32.4	38.2
Eye spot disease	41.2	35.2	23.5
Ring spot disease	26.2	27.8	33.0
Yellowing disease	28.0	28.0	46.0
White leaf disease	25.9	33.3	40.7
Leaf scald disease	43.5*	17.4	39.1
Stem rot disease	40.0	27.5	32.5
Mosaic	22.9	29.2	47.9*

*****Diseases with highest incidence per region in three Regions of Cameroon

4. Discussion

Diseases have always been a major cause of reduced quality and quantity of plants worldwide. Various biological agents including bacteria, fungi, viruses and phytoplasma cause diseases of sugarcane. Important diseases of sugarcane have been identified worldwide. Diseases often lead to large yield losses. In China, sugarcane smut, ratoon stunting disease (RSD), mosaic and other diseases cause a greater than 20% reduction in production [12]. Generally, all the landraces and the villages surveyed had sugarcane diseases. The incidence of diseases was high. The highest mean incidence was observed in the West and the lowest was in the Southwest region. Though some farms were well managed, diseases still occurred. The incidence of diseases should be a cause for concern, since these diseases are known to be of economic importance in some developing countries [13]. The environmental conditions generally have an appreciable effect on the incidence of diseases which is generally higher in cold and moist areas. The incidence of the infection is hardly surprising, since host abundance; couple with increasing farming activities in the field in these

locations may lead to a greater spread of mechanical transmitted infections. Most sugarcane yield decline recorded in other parts of the world was related to diseases of sugarcane [14].

The result of red rot disease obtained in the study is not surprising. Red rot and smut are causing the major out-breaks in the recent years causing 30-100% yield loss in commercial sugarcane varieties throughout India [15][16]. Red rot disease is so devastating in nature that it has been referred to as cancer of sugarcane [17]. Fungal diseases have been reported on sugarcane in Buea, in the southwest region of Cameroon [18]. [19], reported that diseases caused by fungi, bacteria, viruses and mycoplasmas-like organisms cause considerable damage to sugar cane. [20] survey results indicated the presence of disease on sugarcane with high incidence. It is precisely at this point, that the role of integrated management of diseases is of utmost importance. Sugarcane growers' awareness on these diseases is however poor and is of major concern. In particular, majority of farmers are ignorant of these diseases in their sugarcane fields. Most of the farmers attributed the symptomatology of these diseases as manifestation of sugarcane decline due to unknown reasons. Some advocated the fact that these diseases can be as a result of lack of certified seeds.

CONCLUSION.

Five local sugarcane landraces were useful in the study community. The problems of disease do exist in the sugarcane production system in these three regions of Cameroon. Therefore, the public should be educated on the danger of losing these landraces due to the diseases encountered. Integrated management plan is of significant to reduce the incidence of disease in order to increase yield. This therefore implies that the plant is paramount to conservation based on degradation as a result of diseases.

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