

Distribution of Sugarcane Diseases in the Philippines

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During the 1950s to 1960s, sugarcane accounted for more than 20% of the country's exports; making it one of the pillars of the Philippine economy. A decade after that, the sugar industry has declined and plummeted leading to a complete crisis in the 1980s. Since then, the industry has been in the process of recovery and building up. However, attempts have been challenged due to several factors including high costs of production, low market price of sugar, labor shortage, and lastly, climate change. During the recent years, climate change has been more damaging due to the emergence and re-emergence of diseases leading to decreased sugar production. Thus, this study aims to diagnose and identify the emerging and re-emerging diseases of sugarcane, assess their distribution, and determine the propensity of commercially grown sugarcane varieties. High prevalence (20-40%) of fungal diseases such as rust, scorch and smut was recorded in all sugarcane fields surveyed. Downy mildew is still a serious disease but its occurrence is highly influenced by varieties of sugarcane and prevailing environmental conditions. Red rot and pokkahboeng, which were previously known as minor diseases, are at an alarmingly high incidence at 65% up to 90%. These two diseases are present in almost all areas surveyed regardless of sugarcane variety planted. For bacterial diseases, leaf scald is the most significant, occurring at about 16% of the sugarcane fields. Finally, virus diseases such as sugarcane mosaic and sugarcane yellow leaf syndrome have the least incidence although these still pose a threat since they are present at 3% to 8% of sugarcane fields. Diseases that were considered minor in the past are now becoming widespread and their impact on yield is not quantified or ignored, such as in the case of pokkah boeng. The reaction of commercial varieties to these diseases had not been assessed and sources of resistance against emerging and re-emerging diseases are still lacking. Thus, more studies must be conducted in order to determine the impact of these diseases on yield.

A survey was done in major sugarcane mill districts in the Philippines including Ilocos Sur, Isabela, Cagayan Valley, Tarlac, Pampanga, Batangas, Cavite, Camarines Sur, Iloilo, Capiz, Negros Occidental, Negros Oriental, Cebu, Leyte, Davao del Sur, North Cotabato, and Bukidnon from 2017 to 2018. At least two fields per municipality were selected in each mill district. A minimum of 100 infected plant samples were collected depending on the field size. Pokkahboeng, red rot, smut, rust, leaf scorch, downy mildew, leaf scald, mosaic and other diseases were recorded and the data were analyzed for disease presence and mean disease prevalence.

Results

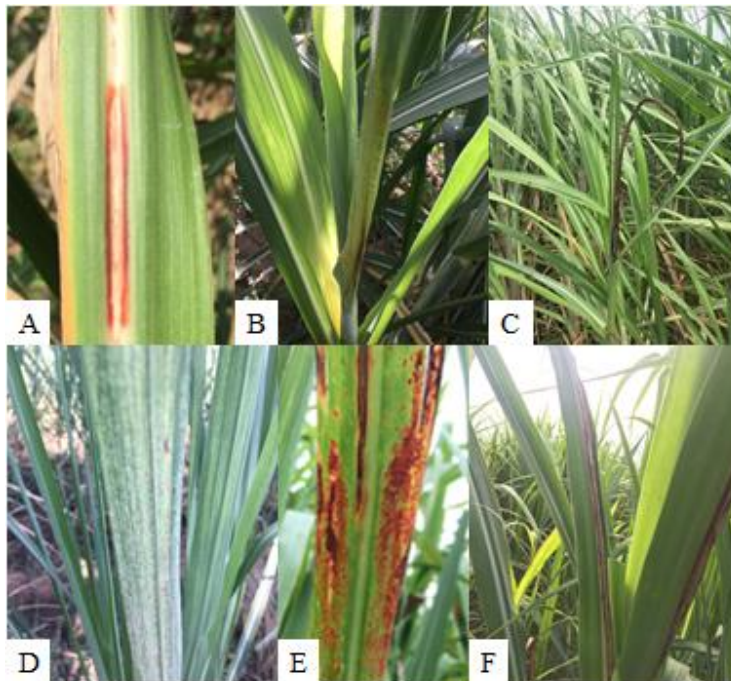


Figure 1. Images showing symptoms of (A) red rot, (B) pokkahboeng (C) smut and (D) downy mildew, (E) rust and (F) scorch, the most prevalent diseases observed from surveyed areas.

Survey results suggest that among the diseases observed, red rot, pokkah boeng, smut, downy mildew, rust, and scorch, all of which are caused by plant pathogenic fungi, were the

most prevalent diseases. On the one hand, leaf scald, which is the only bacterial disease observed, along with two viral diseases, yellow leaf and mosaic, occur at relatively lower incidences.

Table 1. Presence of red rot of sugarcane and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	100	28.34
Visayas	98.51	39.56
Mindanao	100	22.01

Red rot: Red rot was previously known to be caused by *Colletotrichum falcatum*, however a recent study by Dela Cueva *et al.* (2019) proved that both *Fusarium proliferatum* and *F. saccharican* also cause the disease. The disease is readily observed on infected canes since it causes reddening of the leaf midrib. It is considered as the most prevalent disease of sugarcane in the Philippines with the highest incidence observed in Visayas (39.56%) followed by Luzon and Mindanao with 28.34% and 22.01% incidence, respectively.

Table 2. Presence of pokkah boeng disease and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	96	12.48
Visayas	85.07	15.81
Mindanao	96	10.76

PokkahBoeng: Known to be caused by various species of *Fusarium*, pokkahboeng is one of the most prevalent diseases of sugarcane in the country, occurring at 16 out of the 17 sugarcane-growing provinces surveyed. The disease is characterized by apical shoot distortion and necrosis of the entire spindle (Samaco and Dela Cueva, 2018). Disease prevalence ranged from 10.76% to 15.81% on affected areas.

Table 3. Presence of sugarcane smut and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	59.26	10.87
Visayas	58.21	16.23
Mindanao	71.43	7.5

Sugarcane smut. Sugarcane smut, caused by *Sporiorium scitamineum*, is characterized by the turning of young spindle of sugarcane into a whip-like structures (SRA, 2013). Previously known as a major disease of sugarcane in the Philippines, it could cause up to 62% yield loss on susceptible varieties. It is present at almost 60% of the sugarcane cultivating areas in Luzon and Visayas and observed at approximately 70% of the sugarcane growing areas in Mindanao. Infected fields exhibit 7-16% incidence. This is especially serious in Cagayan Valley and Camarines Sur since 90% of the sugarcane fields surveyed in both provinces have the disease.

Table 4. Presence of downy mildew of sugarcane and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	37.04	12.53
Visayas	11.94	11.07
Mindanao	25	3.67

Downy Mildew.Caused by *Peronosclerospora sacchari*/*Peronosclerospora philippinensis*, downy mildew is characterized by streaks that run parallel to the veins and white powdery structures on the underside of the infected leaf (SRA, 2013). Its presence and prevalence is highest in the island of Luzon; recorded in 71% of the sugarcane fields in Cagayan Valley and notably prevalent in Isabela at 31% of affected fields.

Table 5. Presence of rust disease of sugarcane and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	46.3	2.3
Visayas	46.27	13.64
Mindanao	50	17.08

Rust.Considered as a foliar disease, rust, caused by *Puccinia melanocephala*, causes small, elongated yellowish spots on both leaf surfaces; that may later coalesce, forming large, necrotic areas (Raid and Comstock, 2006). The disease is present in Luzon, Visayas and Mindanao, but is notably serious in both Negros Occidental and Bukidnon, occurring at not less than 80% of the sugarcane fields surveyed.

Table 6. Presence of leaf scorch and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	33.38	3.1
Visayas	23.28	6.27
Mindanao	39.29	6.25

Scorch.Sugarcane leaf scorch caused by *Stagonospora sacchari* is characterized red to dark brown minute spots which later coalesce, blighting the entire leaf (Eaganathan et al., 2014). It is present in 20-40% of sugarcane areas in the Philippines, although its prevalence is at less than 10% of the infected fields. Highest disease incidence of 85% was recorded at Cagayan Valley.

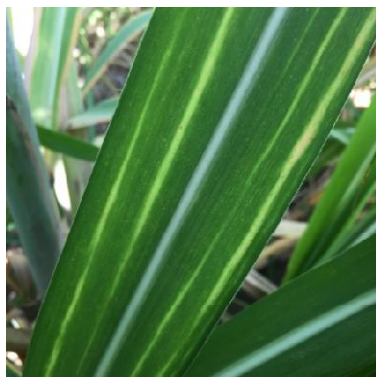


Figure 2. Infected sugarcane leaf showing chlorotic pencil line streaks, characteristic symptom of leaf scald.

Leaf Scald.Leaf scald of sugarcane is a bacterial disease known to be caused by *Xanthomonas abilineans*. It is present at 38.89% of the sugarcane fields in Luzon and observed in no less than 50% of the surveyed areas in both Visayas and Mindanao. It has a prevalence of less than 10% per infected field. The disease is frequently observed in North Cotabato and Davao del Sur occurring at more than 70% of the sugarcane fields surveyed.

Table 7. Presence of leaf scald of sugarcane and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	38.89	2.54
Visayas	53.73	5.13
Mindanao	57.14	4.85



Figure 3. Sugarcane leaf showing typical mosaic symptoms.

Mosaic. Sugarcane mosaic is a viral disease characterized by laminar mottling of the leaves that leads to stunting. It has a very wide host range infecting various graminaceous crops such as sorghum, maize and numerous wild grasses. It is present in less than 20% of sugarcane fields surveyed in the Philippines.

Table 8. Presence of sugarcane mosaic and its prevalence on affected areas.

Area	Presence(%)	Prevalence(%)
Luzon	12.96	3.25
Visayas	10.45	4.2
Mindanao	17.86	5.42

Other diseases such as sugarcane yellow leaf virus, maize streak etc. were also recorded at less than 1% prevalence.

Discussion

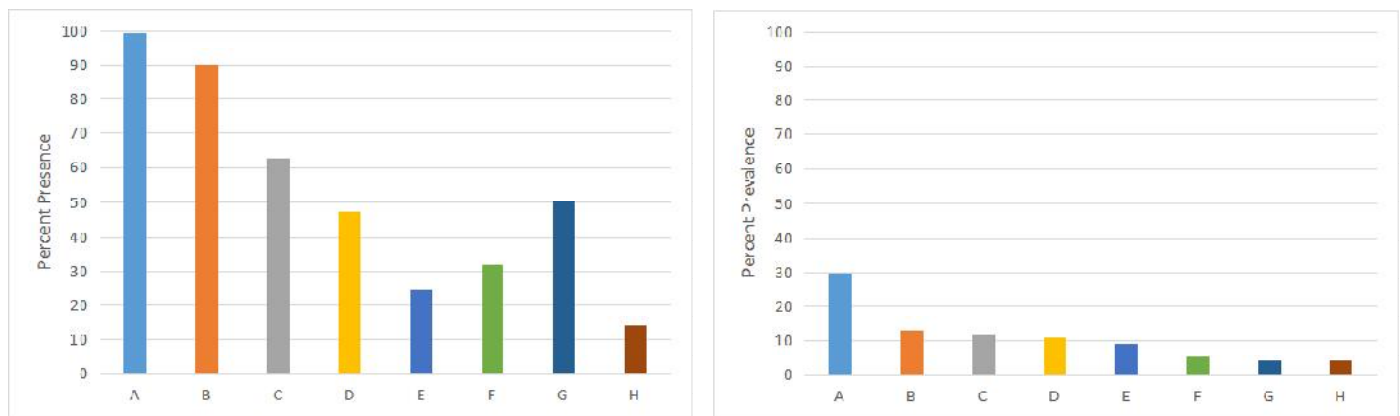


Figure 4. Presence and prevalence of the major sugarcane diseases in the Philippines: A) Red Rot B) Pokkah Boeng C) Smut D) Rust E) Downy Mildew F) Leaf Scorch G) Leaf Scald H) Sugarcane Mosaic

Results of this study identified eight major diseases of sugarcane in the Philippines. These include fungal diseases, red rot, pokkah boeng, smut, downy mildew, rust and scorch; a bacterial disease, leaf scald, and a viral disease, mosaic. The degree of presence of the mentioned diseases can be discriminated into three, the first group being the most prevalent, occurring at more than 90% of the sugarcane fields in the Philippines, includes red rot and pokkah boeng; the second group is formed by sugarcane smut, rust, and leaf scald, occurring in no less than 50% of

the country's sugarcane growing areas and; the third, composed of both downy mildew and mosaic, observed at less than 30% of the country's sugarcane fields.

The reaction of commercial varieties to these diseases had not been assessed and sources of resistance against emerging and re-emerging diseases are still lacking. Thus, more studies must be conducted in order to determine the impact of these diseases on yield.

To our knowledge, this is the first study outlining the distribution of emerging and re-emerging diseases of sugarcane in the country. This information will prove to be of value to sugarcane breeders and allied professionals.

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