Journal of Sugarcane Research (2020) **10**, 186-197
https://doi.org/10.37580/JSR.2020.2.10.186-197

SHORT COMMUNICATION

Distribution scenario of diseases in sugarcane germplasm at Kannur, Kerala

R. Gopi[a*], R.Viswanathan[b], K. Chandran[a], M. Nisha[a], B. Mahendran[a], P. P. Girishan[a] and Mayalekshmi[a]

[a]*ICAR-Sugarcane Breeding Institute, Research Centre, Kannur, Kerala, India*
[b]*ICAR-Sugarcane Breeding Institute, Coimbatore, India*

*Corresponding author: Email: ramaraj.muthu.gopi2@gmail.com

(Received 05 May 2020; accepted 10 January 2021)

Abstract
Survey and monitoring were done at monthly intervals during 2017-2019 for the occurrence of diseases in sugarcane germplasm at ICAR-Sugarcane Breeding Institute Institute Research Centre, Kannur. The study revealed the occurrence of ring spot in *Saccharum* species as well as in hybrid clones. Other diseases recorded were smut, rust, stalk rot, banded sclerotial disease and YLD. Among these diseases, only few clones such as IJ 76 552 and 28 NG 82 (*Saccharum robustum*), Co 844 and Co 62175 (Indian hybrids) were affected by smut. Rust is the common disease in the 32 hybrid clones and in four clones of *S. spontaneum viz*. IND 81-20, IND 81-74, IND 81-82 and IND 81-83. Only one *S. officinarum* clone IJ 76 501 was affected by rust till now. Stalk rot was observed mostly in *S. officinarum* clones and in few hybrid clones, respectively during 2017-2019. For the first time, leaf blight due to banded sclerotial disease was noticed in NG 77-145 of *S. robustum*, Agoul, Baroukha, Chin and Dark Pindaria of *S. barberi* and IS 76-168 of *S. officinarum* during 2019.

Keywords: Sugarcane; Germplasm; Diseases; Incidence; India

Crop improvement programme in sugarcane is relied on the diversity of collection available in the gene bank. The world largest collection of sugarcane germplasm is maintained at ICAR-Sugarcane Breeding Institute, Research Centre, Kannur (11° 52' N, 75° 25' E) which distinguishes as a crop island, since there is no large-scale cultivation of sugarcane in the neighbourhood (Mahesh et al. 2014). More than 3300 sugarcane germplasm comprising *Saccharum officinarum*, *S. barberi*, *S. sinense*, *S. robustum*, *S. spontaneum* Indian hybrids, foreign hybrids and other allied genera are maintained in the field gene bank. Germplasm collections from different geographical regions with maximum diversity for yield and quality characters serve as source material in the breeding programme. Apart from the initial shipping of the world collection from USDA, germplasm accessions from national and international expeditions are added regularly after quarantining at Coimbatore (Viswanathan et al. 1999). Germplasm harbours various pests and diseases which affect the health of sugarcane plants and cause general reduction in vigour of the clones. Diseases are the major constraint to sugarcane cultivation in general and various fungal and viral diseases affect sugarcane germplasm. More than 240 diseases have been reported from all over the world in sugarcane (Rott et al. 2000). About 10–15 % of the nation sugar produced is lost due to the diseases in India (Viswanathan and Rao 2011). Red rot, smut, rust, wilt, leaf scald, yellow leaf disease (YLD), grassy shoot disease (GSD), ratoon stunting disease (RSD) and mosaic are the important diseases (Viswanathan and Rao 2011; Viswanathan 2012). Sugarcane elite germplasm clones are regularly screened for resistance against major diseases and pre-breeding

population is generated regularly to introduce new genes for various traits in the cultivated varieties. Recently, utilization of different inter-specific and inter-generic hybrids possessing resistance against red rot was documented based on the detailed testing at research centre as well in Coimbatore (Viswanathan et al. 2018).

Survey, monitoring and identification of diseases play a vital role for the successful germplasm conservation and maintenance at Sugarcane Breeding Institute, Research Centre, Kannur. Timely surveys and surveillance are also very important to avoid economic losses caused by diseases and thus help in planning appropriate management measures in commercial sugarcane varieties (Viswanathan 2012). Considering the importance of germplasm clones in development of high yielding varieties coupled with qualitative traits, the regular surveillance work was done during 2017-19 to identify diseases regularly occurring in sugarcane germplasm maintained at Kannur, Kerala.

Sugarcane germplasm materials studied in this work were grown in 6ft rows with row-to-row spacing of 90 cm following recommended agronomic management practices. Disease incidence was scored for ring spot, Pokkah boeng, smut, YLD and stalk rot, whereas per cent disease index (PDI) was calculated for rust by using 0-9 scale, where 1 = chlorotic flecks, less than 5 lesions per leaf; 3 = 5 to 30 lesions per leaf; 5 = more than 30 lesions per leaf; 7 = some leaves with densely concentrated lesions; and 9 = high lesion density on most leaves (Avalleneda et al. 2015) and per cent affected clones were recorded using the following formula.

$$\textbf{Per cent clones affected} = \frac{\text{Number of clones affected}}{\text{Total number of clones observed}} \times 100$$

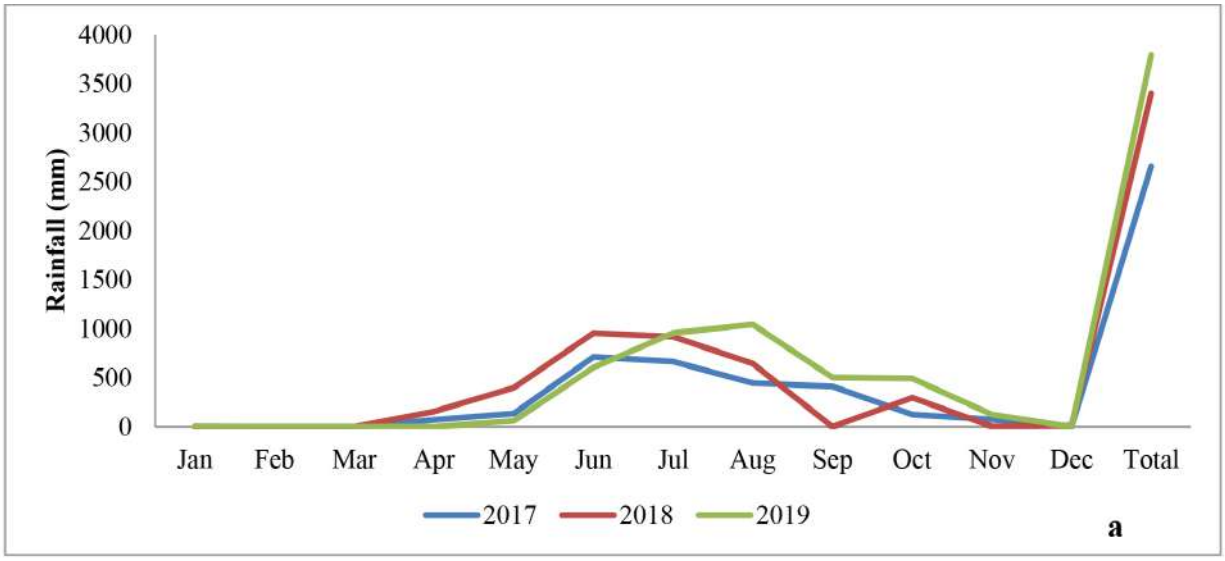
Per cent disease index (or Disease severity index) =PDI was calculated based on the following formula

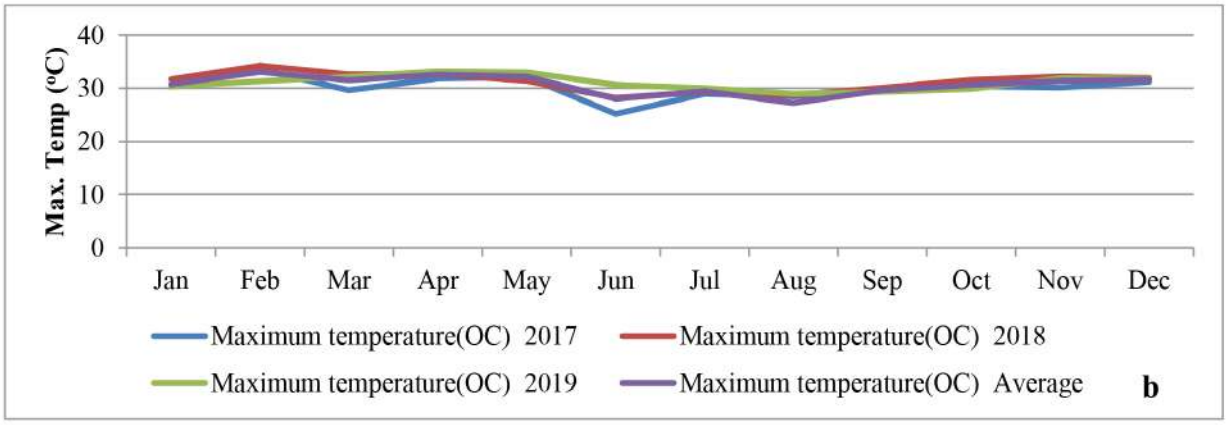
$$\textbf{PDI} = \frac{\text{Total score} \times 100}{\text{Total number of plants observed} \times \text{maximum disease score}}$$

During regular monitoring for diseases in different germplasm it was noticed that diseases start appear with the onset of monsoon in the month of June. The diseases observed during 2017-19 were ring spot, smut, rust, pokkah boeng, banded sclerotial disease, YLD and leaf fleck caused by Sugarcane bacilliform virus (SCBV) (Fig 1). Among the diseases, ring spot was the most predominant one followed by rust, stalk rot, pokkah boeng, smut, YLD and banded sclerotial disease. The germplasm maintained at Kannur are totally free from the red rot and the viral disease mosaic due to strict quarantine measures observed during the addition of new accessions by introduction/ indigenous collection. However, testing of these clones under artificial condition showed varying reaction from susceptible to resistant against red rot at Coimbatore (Viswanathan et al. 2017). The diseases like ring spot, pokkah boeng and rust were observed in the month of June when rainfall is high whereas, smut, stalk rot, blight, and YLD were observed during the end of monsoon season in September and October (Table 1) when rainfall is comparatively less (Fig 1).

***Ring Spot* (*Leptospheria sacchari*)**

Leaf spot caused by *Leptospheria sacchari* is a very common disease among the germplasm clones, although its economic impact is very less (Rott et al. 2015). It has been reported earlier in germplasm clones of Florida (Bourne 1930) and





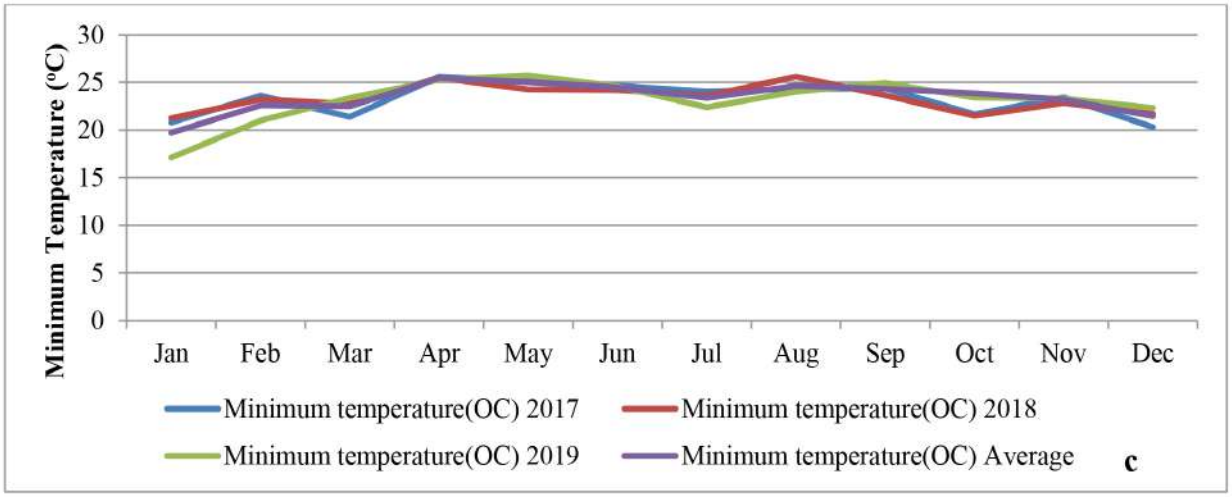


Figure 1. Rainfall (a), maximum temperature (b) and minimum (c) temperature pattern during 2017-2019 at Kannur

Table 1. Diseases and month of occurrence

S. No	Diseases	Month of occurrence
1.	Ring spot	June-December
2.	Smut	October- December
3.	Pokkah boeng	June-December
4.	Rust	June-December
5.	Stalk rot	November- December
6.	Banded sclerotial disease	September- December
7.	YLD	October- December

also in Kannur (Chandran et al. 2012, 2015, 2016). Over last three years of observation showed that germplasm clones were infected by leaf spot at varying diseases intensities. Among the germplasm studied, all the clones in *S. sinence*, *S. spontaneum*, foreign hybrids and Indian hybrids recorded ring spot. In *S. officinarum* per cent infected clones were 99.86%, 100% and 100% during 2017, 2018 and 2019 respectively (Table 2). Per cent infected clones in *S. barberi* were 92.85% for both 2017 and 2018 and 100% for the year 2019 whereas *S. robustum* recorded 93.10%, 84.13% and 88.27% infected clones respectively during 2017, 2018 and 2019. Most of clones except few recorded with 100% incidence of ring spot disease. In 2017, three clones of *S. barberi* (K 124, Matna Shaz and Mungo 237) were found free from the disease. In 2018, three clones of *S. barberi* (Baroukha, Katha Coimb, Pararia Shaj) and 23 *S. robustum* clones (IJ 76-416, IJ 76-440, IJ 76-445, IJ 76-482, IJ 76-535, IJ 76-547, NG 77-1, NG 77-3, NG 77-23, NG 77-35, NG 77-38, NG 77-39, NG 77-53, NG 77-75, NG 77-76, NG 77-78, NG 77-84, NG 77-88, NG 77-90, NG 77-132, NG 77-136, NG 77-146, NG 77-238) were found free from ring spot incidence. During 2019, *S. robustum* clones Mol 4503, Mol 4861, Mol 5099, Mol 5698, NG 77-3, NG 77-21, NG 77-23, NG 77-24, NG 77-32, NG 77-34, NG 77-35, NG 77-38, NG 77-39, NG 77-73, NG 77-75, NG 77-76 and NG 77-122 were disease free.

***Smut* (*Sporisorium scitamineum*)**

Smut is one of the important diseases reported all over the world except Fiji (Ramesh Sundar et al. 2012). The affected cane produces a black, about pencil-thick and unbranched whip-like structure of few centimetres to over a meter in length from the cane top or side branches of germinating buds. At Kannur, during the study period only four clones were found infected with smut (Table 2). During 2017, only one clone Co 844 had infection. Two clones of *S. robustum viz.* IJ 76 552 and 28 NG 82 were found infected during 2018 whereas Co 62175 showed smut infection during 2019. Same clones were not found infected in subsequent years. Regular monitoring, identification, careful removal of the infected clones and hot water @ 52^{o} for 30 min + fungicide (Carbedazim @ 0.1%) treatment before planting might have contributed for lesser incidence of smut. The disease was not observed in *S. officinarum*, *S. barberi*, *S. sinense* and *S. spontaneum* clones during the study period. The disease was noticed in October to December during the study period where rainfall is low and maximum temperature is high and minimum temperature is low in comparison to other months (Fig. 1). From the study it was observed that S. *robustum* clones were more susceptible to smut in comparison to other clones. In previous years also

Ring spot

Smut

Pokkah boeng

Rust

Stalk rot

Banded sclerotial disease

Yellow Leaf Disease (YLD)

Sugarcane Bacilliform Virus Disease (SCBV)

Figure 2. Diseases in sugarcane germplasm recorded at ICAR-Sugarcane Breeding Institute Research Centre, Kannur

Table 2. Percentage and number of clones affected by various diseases in sugarcane germplasm at Kannur

S. No	Diseases	Percentage and number of clones																				
		Saccharum officinarum			*S.barberi*			*S. sinense*			*S. robustum*			*S. spontaneum*			Foreign hybrids			Indian hybrids		
		2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
1	Ring spot	99.86 (756)	100 (757)	100 (757)	92.85 (39)	92.85 (39)	100 (42)	100 (30)	100 (30)	100 (30)	93.10 (135)	84.13 (122)	88.27 (128)	NS	NS	NS	100 (614)	100 (614)	NS	100 (1031)	100 (1031)	NS
3	Smut	0.13 (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.3 7 (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09 (1)
4.	Pokkah boeng	0.39 (2)	0.13 (1)	1.18 (8)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14 (7)	0.16 (1)	0.16 (1)	0.09 (1)	0.09 (1)	0.00
5	Rust	0.00	0.13 (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04 (4)	1.04 (4)	1.04 (4)	0.00	1.3 (8)	0.00	0.29 (3)	2.13 (22)	3.10 (32)
6	Stalk rot	1.32 (10)	4.75 (36)	1.98 (15)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14 (7)	1.46 (9)	1.30	0.19 (2)	0.38 (4)	0.00
7	Leaf blight	0.00	0.00	0.13 (1)	0.00	0.00	9.52 (5)	0.00	0.00	0.00	0.00	0.00	0.68 (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	YLD	0.00	0.39 (3)	0.13 (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.06 (3)	0.00	0.00	0.00	0.00	0.00	0.32 (2)	0.00	0.00	0.00	0.00

*NS-Not Studied

clones from *S. robustum* like IJ 76-481, IJ 76-482 and NG 77-122, NG 77-13 and IK 76-64 showed smut incidence (Chandran et al. 2011, 2013, 2015). Smut whip was also recorded in Co 905, Khari (*S. barberi*) and foreign hybrid clone (CP 31-294) in previous years (Chandran et al. 2014, 2016).

In the past, smut has been a major threat to germplasm conservation at Kannur. Viswanathan (unpublished) had documented information on smut in several germplasm clones especially *S. robustum*. *S. officinarum,* foreign and Indian hybrids during 1980s and 1990s. In total he found smut in 79 genotypes. The following clones Saretha, IJ 76-536, NFG 77-13, NG 77-108, NG 77-239, H 50-7000, IJ 76-499, Larli, IJ 76-184, IJ 76-337 etc were frequently recorded with smut whips during 1980s. Inspite of systematic hot water treatment every year to the affected and adjoining clones the smut incidences did not come down. Later he investigated on the alternate sources of smut inoculum and discovered the role of a grain smut *Specilia sorghii* infecting *Ischaemum ciliare*, a creeping grass on the field bunds, in causing whip smut in germplasm clones (Viswanathan et al. 1998, 2000). Subsequently the grass host was removed and smut severity in the germplasm was contained. Currently few clones getting smut infection may be due to the inoculum carried through the vegetative planting materials for several seasons. Once a threshold level of inoculum is built in the growing plant probably whip emergence would occur.

***Pokkah boeng* (*Fusarium sacchari*)**

It is caused by various species of *Fusarium* spp. in different countries. In India *Fusarium sacchari* is identified as the pathogen of Pokkah boeng (PB) as well as wilt (Viswanathan et al. 2017). Once it was considered as minor disease, however, in the recent years it is becoming one of the major diseases in sugarcane (Viswanathan 2018). Karuppaiyan et al. (2015) also reported PB disease incidence ranged from 6.9 to 25.30 % in commercial varieties. More than 90% incidence in some varieties in Uttar Pradesh was also recorded (Vishwakarma et al. 2013). The yield loss varied from 40-60% (Goswami et al. 2013). Patil et al. (2007) described three phases namely chlorotic, acute and knife-cut phases of the disease. A total of 10 clones comprising, two clones (IJ 76- 322, IK 76-70) of *S. officinarum*, seven clones (Q 56, Q 68, C 4772, CP 61-84, PR 1065 and PT 48-44, M 1900) of foreign hybrids and one clone of Indian hybrids Co 1002 with highest percent clones were found affected in foreign hybrids (1.14%) during 2017. The *S. officinarum* clone IK 76-70 recorded maximum incidence (41.66). In case of foreign hybrids, Q56 and Q68 recorded maximum disease incidence (60%, 12.17%, respectively). The disease incidence was 14.73% in Co 1002 of Indian hybrids. Only three clones IJ 76- 322 (23.52% disease incidence) of *S. officinarum*, Co 62153 (25%) and Q 55 (13.33%) of foreign hybrids expressed PB symptoms during 2018 with per cent contribution of 0.13, 0.16 and 0.09, respectively. Nine clones of *S. officinarum* Koeng, Rastali, 96 NG 24A, 28 NG 80, 28 NG 263, 57 NG 184, IK 76- 2, IK 76- 19 and IK 76- 94, and one clone Q 66 of foreign hybrid expressed PB symptoms in 2019. Maximum incidence of the disease was noticed in IK 76- 2 (73.91%) and maximum canes were found infected in this particular clone, whereas, only one or two plants showed chlorosis in other clones. Among the three phases, chlorosis phase was very common among the clones infected and only chlorosis was noticed during 2018 and 2019 whereas knife cut symptom was noticed in Co 1002 and top rot was found in IJ 76-70 of *S. officinarum* during 2017. Most of the clones recovered from PB and some clones like IK 75-70, IJ 76-322 and IK 76-2 exhibited stalk rot on the infected clumps. This may be due to high rainfall during 2018 (3400 mm) and 2019 (3800

mm) in comparison to 2017 (2600 mm) (Fig. 1a). Rainfall also was high during June-August (2018-19) which might have caused washing of spores by rainfall. Rainfall might have some influence on occurrence of this disease. The severe incidence of the disease occurred in the temperature range between 20 and 32°C and in rainy season (Osman et al. 2014). The notable losses from PB have occurred where susceptible varieties have been grown in a climate, in which hot and dry season is followed by a wet season (Lin et al. 2015). Anuradha et al. (2018) found that disease initiated in the first fortnight of June and gradually increased till September. Pokkah boeng symptoms were also noticed in previous years in some clones of *S. officinarum*, *S. sinense*, *S. barberi*, *S. robustum* and foreign hybrid collections (Chandran et al. 2011). Earlier studies recorded PB in Black Cheribon, Blanche reunion, NC 24 purple, Tibo Mird, Tjepering, IK 76-70, 57 NG 259 of *S. officinarum* and Cato, Q56, CP 29-120, P 33-11, P 33-37, F 1108, POJ 2725 of foreign hybrids in June 2013 (Chandran et al. 2014). Monitoring in May 2014 also showed early symptoms of PB in 10 Co canes (Co 952, Co 1032, Co 1164, Co 62149, Co 62154, Co 62157, Co 62169, Co 62211, and BO 24, and three foreign hybrids *viz*., Q 69, CP 1161 and PR 1069 (Chandran et al. 2015). Similarly, PB incidence was noticed in June, 2015 in 41 *S. officinarum* clones, one *S. sinense* and six foreign hybrid clones (Chandran et al. 2016).

Earlier studies conducted at ICAR-SBI revealed that PB occurred suddenly in the parental clones maintained at National Hybridization Garden (NHG) during 2010-12 for three seasons and adversely affected the plants. Many clones exhibited severe forms of PB like top rot and knife cut symptoms. Another interesting finding was that PB infection led to systemic wilt in several clones, thereby caused total death of the affected canes (Viswanathan et al. 2014). Subsequently an important discovery was made on epidemiology of *Fusarium* diseases affecting sugarcane, in which the same *F. sacchari* causing both PB and systemic wilt was established (Viswanathan et al. 2017). In the earlier studies on sugarcane wilt in germplasm clones Poongothai et al. (2014a,b) documented variability in 18 isolates of *F. sacchari* infecting *S. officinarum*. Hence further studies are required on systemic wilt from PB affected canes in the germplasm.

***Rust* (*Puccinia* spp)**

During 2017 four clones of *S. spontaneum* (IND 81-20, IND 81-74, IND 81-82, and IND 81-83) and three clones of Indian hybrids Co 658 (31.11%), Co 698 (60%) and Co 699 (53.33%) were found infected by brown rust. The per cent severity was maximum in Co 698 across the infected germplasm clones. During 2018 one IJ 76- 501 of *S. officinarum* clone, four clones of *S. spontaneum* IND 81-20, IND 81-74, IND 81-82, and IND 81-83, eight foreign (1.3%) hybrid clones CP 84 1198, CP 94 1100, CP 81 1389, CP 78 1628, CP 44-155, CP 63-313, POJ 2714, ORB 6 and 22 (2.13%) Indian hybrid clones namely Co 356, Co 359, Co 360, Co 376, Co 388, Co 462, Co 463, Co 464, Co 508, Co 519, Co 629, Co 955, Co 1041, Co 1042, Co 1052, Co 1091, Co 1054 Co 6305, Co 62018, Co 62021, Co 62101 and Co 6495 were found infected. Maximum disease severity of 55.55% was recorded in clones Co 360 and Co 508 during 2018. During 2019, four clones (IND 81-20, IND 81-74, IND 81-82, and IND 81-83) of *S. spontaneum* and 32 (3.1%) clones of Indian hybrids like Co 302, Co 349, Co 376, Co 377, Co 386, Co 388, Co 508, Co 517, Co 519, Co 612, Co 656, Co 693, Co 694, Co 698, Co 699, Co 707, Co 769, Co 813, Co 815, Co 1041, Co 1042, Co 1050, Co 1053, Co 1054, Co 1057, Co 1097, Co 1221, Co 62037, Co 62039, Co 62161, CoS 568 and Co 6305 recorded rust incidence. Maximum disease severity was observed in Co 376 (73.33%)

followed by Co 699 (60%) and CoS 568 (51.11%). Previous workers observed rust in ORB 6 clone of foreign hybrids during 2011, 2012 and 2013 (Chandran et al. 2013, 2014).

***Stalk rot* (*Phaeocytostroma sacchari*)**

It is caused by *Phaeocytostroma sacchari*, has been reported from more than 50 cane growing countries and first reported in India by Viswanathan et al. (2003). The per cent disease incidence ranged from 50-65% with maximum in D 1135 during 2017**.** Ten clones *viz*. Barbodose white sport, Branchure, China, Chapina, Fiji 60, Khajuria, Listada, Manteiga-1295, Senneville and NC 78 of *S. officinarum*, 7 clones of foreign hybrids D 1135, D 1135 STR, CP 59-22, CB 40-13, B 43-380, H 44-2818 and R 70-8 and two clones of Indian hybrids Co 431 and Co 749 were noticed with the disease (Table 2). Among the germplasm clones, maximum per cent clones (1.32%) affected were found in *S. officinarum* in the year 2017. A total of 36 clones (4.75%) like Assam red, Desi Pounda, Fiji 38, Fiji 62 STR, Ireng Malang, Rasdali, 28 NG 1, 28 NG 189, 28 NG 257, 28 NG 260, 51 NG 11, 51 NG 41, 51 NG 43, 51 NG 53, 51 NG 56, 51 NG 59, 51 NG 122, 51 NG -124, 51 NG 126, 51 NG 131, 51 NG 133, 51 NG 134, 51 NG 137 STR, 51 NG 138, 51 NG 147, 51 NG 240, 51 NG 243, IS 76 116, IS 76 161, IS 76 168, NG 77 28, NG 77 31, NG 77 42, NG 77 171, Patta Cherukku, Patta Patti of *S. officinarum* and 9 clones H 50-723, PT-47, D1135, D 1135 STR, D 109, POJ 2222, POJ 2714, LF 69-1080, LF 70-1024 of foreign hybrids and four Indian hybrids namely Co 1115, Co 404, Co 415, Co 97026 showed stalk rot incidences with more than 70% incidence in many of the clones in 2018. Fifteen clones from *S. officinarum viz.,* Castilla, Guam A, Listada, NB 32, 51 NG 66, 51 NG 124, 51 NG 126, 51 NG 127, 51 NG 130, 51 NG 133, 57 NG 62, 156, 159, 177, NG 77 103 and eight foreign hybrid clones TUC 472, 521, Akbar, Diamond 10, Q 48, PT 48-44, POJ 2714, POJ 2690 recorded stalk rot incidences during 2019. The per cent incidence varied between 15% (Guam A) and 100% (51 NG 126). Most of the plants having stalk rot appeared stunted and sick and showed Sugarcane Bacilliform Virus (SCBV) infection and also earwig damage. During 2019 also maximum clones with stalk rot incidence was recorded in *S. officinarum* clones (1.98%). Viswanathan et al. (2003) found stalk rot in 125 clone of total germplasm maintained at Kannur. During 2010-11, two clones 57 NG 156 and 57 NG 159 belonging to *S. officinarum* exhibited stalk rot symptoms (Chandran et al. 2011).

Banded sclerotial disease

Banded sclerotial disease symptom in sugarcane is caused by *Rhizoctonia solani* and this pathogen has been reported in number of crops including rice and maize and cause sheath blight (Kuiry et al. 2014). Saifuddin and Sheikh (2016) reported *R. solani* in sugarcane from Uttar Pradesh. For the first time, blight symptom on leaves due to this disease caused by *R. solani* was observed in NG 77-145 of *S. robustum*, Agoul, Baroukha, Chin and Dark Pindaria of *S. barberi* and IS 76 168 of *S. officinarum* during 2019. Per cent disease incidence was 30% in Dark Pindaria and in others only one or two leaves showed infection.

Viral diseases

Many viruses are known to infect sugarcane worldwide. Important diseases *viz*., YLD, mosaic and leaf fleck are major causes for varietal degeneration in sugarcane (Viswanathan 2016, 2018). Leaf fleck was very common in Castilla and Listada of *S. officinarum* and also foreign hybrid clones D1135, D1135 STR in all three seasons. The per cent YLD affected clones was maximum in *S. robustum* (2.06%) in 2018 (Table 2). During 2018, YLD symptoms were noticed in

28 NG 10, NG 77 61, IJ 76-552 of *S. officinarum*, CP 94-1340, CP 33-243 of foreign hybrids and IJ 76-427, IJ 76- 494, MOL-4503 of *S. robustum*. Maximum per cent of YLD incidence of 35.29 was recorded in MOL-4503. In 2019, only NG 77 31 showed YLD symptoms and other germplasm clones were apparently found healthy. Previous studies recorded YLD in Lahi 14, 28 NG 10, IJ 76-427, IJ 76-440, IJ 76-494, IJ 76-499 in 2013, 57 NG 223 and Mauritius 131 in *S. officinarum* and NG and IJ 76 series of *S. robustum* (Chandran et al. 20112, 2014, 2016). The clones like Listada, Pilimak 60, Stripped Tanna and SS-57-3 showed mosaic symptoms (Chandran et al. 2016).

In India red rot, smut, wilt, rust, leaf scald, YLD, RSD and GSD are the major diseases in sugarcane. However, leaf spot, rust, smut, stalk rot, pokkah boeng, YLD and leaf fleck (SCBV) were recorded during the study period. Non-occurrence of other diseases may be due to lack of inoculum to initiate the disease or lack of favourable environment for the disease development. The Banded sclerotial disease (*R. solani*) has been noted in recent times. Though, the diseases are managed with the fungicides, cultural practices, hot water treatment *etc*. . The resistant donors play a crucial role for disease management in sugarcane. In this regard, germplasm is a vital source for breeding new improved varieties. Therefore, disease monitoring and surveying is an integral part of maintenance of germplasm clones. The present study recorded diseases like ring spot, rust, smut, stalk rot, leaf blight, and YLD *etc.,* only based on visual observation of symptoms expressed by the clones giving preliminary idea about the occurrence of diseases in germplasm under the prevailing weather conditions at Kannur. For detailed investigation on resistance among the clones, all the clones have to be tested in endemic areas and in controlled conditions for various diseases in future.

Acknowledgement

Authors are thankful to the Director, ICAR-Sugarcane Breeding Institute, Coimbatore for providing the facilities to complete this research.

References

Abbott EV, Wismer CA, and Martin JP. 1964. Rind disease. In: Sugarcane Diseases of the World Vol. It, eds. C.G. Hughes, E.V. Abbott and C.A. Wismer, Elsevier Pub. Co., Amsterdam. P. 125-130.

Anuradha, Sanghera GS, Kashyap L, Kumar R, Pal R, Singh P. 2018. Incidence of pokkah boeng disease on sugarcane clones and varieties in Punjab. Agriculture Research Journal. 55 (4) : 754-756.

Anuradha, Kumar R, Kaur P, Kashyap L, Sanghera GS, Singh P. 2019. Survey and surveillance of sugarcane diseases in Punjab. India. Agriculture Research Journal. 56 (2): 345-347.

Avalleneda MC, Hoy JW, Pontif MJ. 2015. Screening for resistance to sugarcane brown rust with controlled conditions inoculation. Plant Disease. 99: 1633-1839.

Bourne BA. 1930. The occurrence of the ring-spot disease of sugar-cane in Florida. Phytopathology. 20(4): 364–365.

Chandran K, Nishha M, Ramesh Sundar A, Singaravelu B, Mahesh P. 2011. Maintenance of world collection of sugarcane germplasm. Annual Report 2010-11. Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 111.

Chandran K, Nishha M, Ramesh Sundar A, Mahesh P. 2012. Maintenance of world collection of sugarcane germplasm. Annual

Report 2011-12. Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 115.

Chandran K, Nishha M, Mahesh P, Jayakumar V. 2013. Maintenance of world collection of sugarcane germplasm. Annual Report 2012-13.Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 140.

Chandran K, Nishha M, Mahesh P, Jayakumar V. 2014. Maintenance of world collection of sugarcane germplasm. Annual Report 2013-14. Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 144.

Chandran K, Nishha M, Mahesh P, Jayakumar V. 2015. Maintenance of world collection of sugarcane germplasm. Annual Report 2014-15. Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 149.

Echavez-Badel R. 1990. Incidence of ring spot disease in sugarcane. Journal of Agriculture University of Puerto-Rico. 74(4): 457-459.

Goswami D, Handique PJ, Deka S. 2013. Rhamnolipid bio surfactant against *Fusarium sacchari* the causal organism of Pokkah boeng disease of sugarcane. Journal of Basic Microbiology. 54(6): 1-10.

Karuppaiyan R, Bakshi R, Ramdiya S, Masawwar A, Meena MR. 2015. The incidence of Pokkah boeng in indigenous and exotic sugarcane (*Saccharum officinarum*) clones. Indian Journal of Agricultural Sciences. 85: 596-601.

Kuiry SP, Mondal A, Banerjee S, Dutta S. 2014. Morphological variability in *Rhizoctonia solani* isolates from different agro-ecological zones of West Bengal, India. Archives of Phytopathology and Plant Protection. 47(6): 728-736.

Lin Z, Zhang Y, Que Y, et al. 2015. Characterization of *Fusarium verticillioide* isolates from Pokkah boeng on sugarcane and the disease incidence in field. Journal of Microbiology and Experimentation. 2 (5):151-157.

Mahesh PJ, Srikanth J, Chandran K. 2014. Is *Popillia clara* Arrow an occasional visitor of sugarcane crop island in a diverse habitat? Insect Environment. 20(2): 50-53.

Osman MAM, Hassan MAE, El-Kholi, MMA, Abdel-Razik AA. 2014. Reaction of certain sugarcane varieties to infection with Pokkah Boeng disease caused by *Fusarium subglutenans*. Asian Journal of Agricultural Sciences. 45 (3): 65-77.

Poongothai M, Viswanathan R, Malathi P, Ramesh Sundar A. 2014. Sugarcane wilt: Pathogen recovery from different tissues and variation in cultural characters. Sugar Tech. 16: 50-66.

Poongothai M, Viswanathan R, Malathi P, Ramesh Sundar A. 2014. *Fusarium sacchari* causing sugarcane wilt: variation in morphological characteristics of the pathogen. International Sugar Journal. 116: 54-63.

Ramesh Sundar A, Leonard Barnabas E, Malathi P, Viswanathan R. 2012. A mini-review on smut disease of sugarcane caused by *Sporisorium scitamineum*. Available from: https://www.intechopen.com/books/botany/-a-mini-review-on-the-status-of-smut-disease-of-sugarcane-caused-by-sporisorium-scitamineum-

Rott P, Comstock JC, Sandhu HS, Rain RN. 2015. Ring spot. University of Florida IFAS Extenseion. Publication #PP321.

Rott P, Bailey R, Comstock JC, Croft B, Saumtally AS. 2000. A Guide to Sugarcane Diseases. Cirad.Issct, Cirad Publications Services, Montepellier, France. p. 339.

Saifuddin A, Sheikh M. 2016. Preliminary investigation suggests soilborne *Rhizoctonia solani* infecting sugarcane in Uttar Pradesh India. Advances in Plant and Agriculture, eISSN: 2373-6402.

Vishwakarma SK, Kumar P, Nigam A, Singh A, Kumar A. 2013. Pokkah Boeng: An Emerging Disease of Sugarcane. Journal of Plant Pathololgy and Microbiology. 4: 170.

Viswanathan R. 2012. Sugarcane Diseases and Their Management, ICAR-Sugarcane Breeding Institute, Coimbatore, India. p. 140.

Viswanathan R, Balaji C G, Selvakumar R, Malathi P, Sundar A R, Prasanth A N, Chhabra M L, Parameswari B. 2017. Epidemiology of *Fusarium* diseases in sugarcane: a new discovery of same *Fusarium sacchari* causing two distinct diseases, wilt and pokkah boeng. Sugar Tech. 19: 638-46.

Viswanathan R, Balamuralikrishnan M, Premachandran MN, Tripathi BK. 1999. Sugarcane Bacilliform virus: Symptoms, detection and distribution in the world germplasm collection at Cannanore. Proceedings of International Society of Sugar Cane Technologists. 23(2): 347-354.

Viswanathan R. 2018. Changing scenario of sugarcane diseases in India since introduction of hybrid cane varieties: path travelled for a century. Journal of Sugarcane Research. 8 (1): 01 – 35.

Viswanathan R, Malathi P, Chandran K, Gopi R. 2017. Screening of sugarcane germplasm for red rot resistance. Journal of Sugarcane Research. 7(2): 100-111.

Viswanathan R, Malathi P, Annadurai A, Naveen Prasanth C, Scindiya M. 2014. Sudden occurrence of wilt and *pokkah boeng* in sugarcane and status of resistance in the parental clones in national hybridization garden to these diseases. Journal of Sugarcane Research. 4 (1): 62-81

Viswanathan R, Padmanaban P, Mohanraj D, Prakasam N, Singh N, Selvakumar R, Malathi P, Ramesh Sundar A. 2018. Status of red rot resistance in wild relatives of sugarcane, *Saccharum spontaneum*, interspecific hybrids and intergeneric hybrids. Journal of Sugarcane Research. 8(2): 169 – 184.

Viswanathan R, Nallathambi P, Padmanaban P, Mohanraj D. 2000. Role of *Spacelotheca sorghii* (Link) Clinton adapted to *Ischaemum ciliare* and *Saccharum* spp. in secondary infection of sugarcane smut. Tropical Agriculture (Trinidad). 77: 83-88.

Viswanathan R, Padmanaban P, Nallathambi P, D. Mohanraj. 1998. Role of *Sphacelotheca sorghii* adapted to *Ischaemum ciliare* and sugarcane on the whip smut in sugarcane. Indian Phytopathology. 51: 373-375.

Viswanathan R, Rao GP. 2011. Disease scenario and management of major sugarcane diseases in India. Sugar Tech. 13: 336–353.

Viswanathan R, Premachandran MN, Balamuralikrishnan M, Jothi R. 2003. A new stalk rot disease of sugarcane caused by *Phaeocytostroma sacchari* in India. Sugar Tech. 5: 61–64.