

Scenario of Sugarcane diseases in Madhya Pradesh – A comprehensive survey

ABSTRACT

Sugarcane is an important commercial crop grown in India. The crop is liable to be affected by more than 50 diseases that substantially cause cane yield and quality reduction. A survey was conducted during 2014-15, 2015-16 and 2019-20 to record the incidence of sugarcane diseases in different sugarcane growing areas of Madhya Pradesh, India. The survey was conducted from 15th May to 15th June (first), 10-30th July (second) and 10 to 30th September (third) at different stages of sugarcane. Results revealed that sugarcane smut was a prominent disease, and most genotypes were affected by 1-18 per cent incidence. The maximum incidence of the smut was recorded on Co J 64. Grassy shoot disease ranged between 1-11 per cent, especially under ratoon conditions. Yellow leaf disease was noticed in most of the varieties growing in the regions, with an incidence of up to 10 per cent. Pokkah boeng disease (PBD) was observed in almost all locations with wide cultivating varieties. The highest incidence of PBD was recorded in Co 99004 (5-23 %) at Narmadapuram and Bohani. Sugarcane mosaic incidence was recorded at 2-20 per cent in Narmadapuram. Red rot incidence was recorded with a range of 2-13 per cent on CoS 88230, Co

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Commented [D2]: Mention the diseases you observed

Commented [D3]: percent

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Lk 8001, Co C 671 and Co 8014. Sugarcane wilt was recorded on two varieties, i.e. CoJ 64 (0-20 %) and Co 94012 (11-33 %). The growing of non-recommended varieties, multiple ratooning and lack of knowledge of seed health have played critical roles in disseminating sugarcane disease in the state. This survey would help minimize the attack of sugarcane diseases in the state by adopting suitable measures.

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Key words: - Sugarcane, Diseases, Incidence, Madhya Pradesh, Red rot, Smut

Introduction:

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop grown in India and plays a crucial role in the economic development of sugarcane-growing farmers nationwide. India is the second largest producer of sugarcane in the world, and Brazil and China are the first and third places occupied, respectively. Sugarcane occupies a powerful position as an agro-industrial crop in the country, covering around 5.01 million hectares with a production of 352.14 million tonnes and productivity of 70.25 tons per hectare (Shukla et al., 2017). Sugarcane is a long-duration crop (one to three years) and is liable to attack by several diseases because of its long duration. Over 50 sugarcane diseases in India are caused by fungi, bacteria, viruses, phytoplasma, and nematodes, causing substantial losses in cane yield and quality (Rott et al., 2000; Viswanathan & Rao, 2011). Whip smut (*Sporisorium scitamineum* (Syn. *Ustilago scitaminea*)), wilt (*Fusarium sacchari*), red rot (*Colletotrichum falcatum* Went, perfect stage, *Glomerella tucumanensis* (Speg.) Arx and Muller) and grassy shoot (*Phytoplasma*) have been infecting sugarcane in all growing areas in India (Joshi & Sharma, 1967; Rao, 2014; Viswanathan & Rao, 2011; Amrate et al., 2019). These diseases have always been a serious concern to the sugarcane industry and farmers. In India, red rot and whip smut are expected to cause sugarcane yield losses of about 30-100 per cent (Viswanathan & Rao, 2011). However, diseases like pokkah boeng (*Fusarium* spp.) and yellow leaf disease have been distributed across the county, seriously threatening sugarcane production.

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Yellow leaf (YL) caused by *Sugarcane yellow leaf virus* (SCYLV) was first reported in Hawaii (Schenck, 1990). In India, YLD was reported in 1999, but now it prevails in most of the sugarcane-growing regions (Viswanathan, 2002). Sugarcane mosaic is another several-decade-old viral disease common in India's sugarcane growing regions and caused substantial yield and quality losses (Viswanathan *et al.*, 2007; Jain *et al.*, 1998). *Sugarcane mosaic virus* (SCMV) and *sugarcane streak mosaic virus* (SCSMV), either alone or in combination, is the causal agents of sugarcane mosaic disease in India (Viswanathan *et al.*, 2007). According to estimates, sugarcane production declined by 19.0 per cent due to disease (Rao, 2014; Viswanathan & Rao, 2011).

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Madhya Pradesh has comparatively less sugarcane occupancy (about one lakh hectares) than neighbouring states like Uttar Pradesh and Maharashtra. However, various insect pests and diseases, which are of national significance, have been common in Madhya Pradesh agro-conditions (Choudhary *et al.*, 2014, 2015, 2018; Amrate *et al.*, 2019a). The farmers usually grow sugarcane wherever the factories have been established and for jaggary purposes. Due to lower area coverage and distribution in pockets, it has been noticed that the incidence of sugarcane diseases is comparatively less than in other states where sugarcane grows intensively (Singh *et al.*, 2007; Amrate *et al.*, 2019b). In recent times, the scenario has changed. The farmers have been used to bringing sugarcane setts of different clones from other states irrespective of their susceptibility or tolerance to various diseases. An increasing and decreasing trend of specific sugarcane diseases has also been revealed during a random survey in different sugarcane-growing regions of Andhra Pradesh (Varma *et al.*, 2020; Manjula *et al.*, 2023). Continuously growing susceptible varieties and taking their ratoon would have changes to establish pathogenic load in specific areas that may further lead to economic loss in yield reduction due to severe disease attacks in the state. Considering the economic significance of sugarcane in the state, a survey programme has been undertaken to document the number of significant diseases affecting sugarcane and their extent of severity and distribution in the state. The survey could be beneficial in selecting appropriate

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varieties and other practices to reduce disease occurrence that would ultimately help improve sugarcane productivity in the state.

Material and Methods

A random survey was conducted to document the disease that infects sugarcane in different growth stages in key growing areas of Madhya Pradesh during 2014, 2015 and 2019. During the survey, naturally occurring diseases of sugarcane were recorded in the districts of Narmadapuram (at Narmadapuram and Bankhedi), Narsinghpur (at Kareli, Gadarwara, Tendukheda and Bohani) and Betul (Amla and Betul). It was conducted thrice a year, targeting the peak appearance of diseases. The first survey was carried out from 15th May to 15th June at the time of cane formation, followed by the second from 10th to 30th July at cane formation, and the third from 10 to 30th September at cane development and maturation. The first survey was targeted to reveal the status of smut. In the second survey, Grassy shoot disease (GSD), yellow leaf disease (YLD) and Pokkah Boeng disease (PBD) were recorded. The third survey aimed to record sugarcane mosaic, red rot, and wilt diseases. During the survey, randomly, 100 plants were observed from different corners of the field, and data were presented in per cent disease incidence. Two or more fields of the same varieties were observed from each location.

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Results and Discussion

Whip smut

The survey revealed that whip smut was one of the major diseases distributed across the sugarcane growing area in the state. During the survey, recognisable symptoms of smut disease were observed, including the emergence of a long, elongated whip covered with black spores from the growing point of shoots or tillers (Figure 1). Affected plants have slender and thin canes with erect and pointed leaves. During 2014, the smut incidence was recorded in all the surveyed locations.

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Among the varieties, Co 7219 (9-11 %) at Narmadapuram, Co J 64 (6-10 and 5-11 %) at Bankhedhi and Kareli and Gadarwara were most affected (table 1). The most common growing variety, Co 86032, had the highest 4-7 % incidence at Amla, Betul. During 2015, the incidence of smut was also higher in Co 7219 (7-10 %) at Narmadapuram, Co J 64 (4-11 %) Bankhedhi, Co 80-14 (6-10 %) at Kareli and Gadarwara. In 2019, smut incidence was comparatively higher in variety Co J 64 (3-18 %) at Bankhedhi and Bohani. Like the previous year, the disease was recorded in almost all the surveyed locations in 2019. The other varieties, such as Co C 671, Co 62175, Co 0238, Co 94012, Co 99004, Co 92005, and Co M 265, were also found to be affected by low levels of smut incidence at various locations in the state during three years of the survey. Smut is a common disease in Madhya Pradesh. However, its incidence varies depending on the varietal scenario and several other factors, such as taking seeds from smut-affected fields, continuous ratooning and cultivation practices, etc. (Amrate et al., 2019a). It has a high potential to reduce cane yield and juice quality (Joshi & Sharma, 1967). Singh (2007) and Amrate et al. (2019a) also indicated smut infection in different sugarcane clones and at different locations in Madhya Pradesh. Anuradha et al. (2019) reported a 1-10 % smut incidence in Punjab. Ramesh et al. (2012) reported that smut is a majorly distributed sugarcane disease in India.

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Grassy shoot disease (GSD)

Grassy shoot disease incidence was recorded on Co 86032, Co C 671, Co J 64 and Co 7219 from Narmadapuram, Bankhedhi, Bohani and Kareli sugarcane growing areas of the state (table 1). In 2014, the highest incidence (5-6 %) was recorded from Co J 64 at Kareli. A similar variety was affected by a high incidence (5-11 %) in Bohani in 2019. However, the incidence was also recorded at 5 per cent in Co 7219 and Co 86032 during the three years of the survey. It was found that the ratoon crop was more affected. The infected plants showed a proliferation of tillers, reduced the length of internodes, and exhibited a typical grassy appearance (Figure 1). The grassy shoot has become a very important disease in India, next only to fungal diseases like red rot, wilt and smut

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(Rao, 2014; Rao & Dhupal, 2002), as recorded a hundred per cent loss in susceptible varieties in many states of India.

Yellow leaf disease (YLD)

In recent years, Yellow leaf disease (YLD) symptoms have been observed in most of the genotypes cultivated in India. It was also observed in Madhya Pradesh on Co J 64, Co 99004, Co 86032, CoVSI 434, Co C 671 and CoS 88230 (Table 1). However, the incidence of YLD was low; only it was comparatively higher in CoVSI 434 and Co 99004 (up to 10 %) at Kareli and Narmadapuram in 2014 and 2015, respectively. YLD infection was also found during a 2019 survey. Mid-rib yellowing during the middle age of the crop that reached the laminar region, followed by drying of the affected mid-rib and adjoining laminar tissue from the leaf tip downwards, were characteristic symptoms noticed during the survey. Several researchers have noticed the incidence of YLD in India in recent times. Viswanathan (2002) observed the incidence of Sugarcane yellow leaf syndrome and its impact on sugarcane yield. Viswanathan (2012) reported that symptoms of yellow leaf disease started at 6-8 months and were characterized by yellowing of the midrib and necrosis of the leaf lamina from the leaf tip spreading downwards along the midrib. YLD has now been prevalent in most sugarcane growing areas, and its intensity has been recorded to be a hundred per cent in certain susceptible sugarcane varieties in India (Rao et al., 2014). Viswanathan (2002) observed characteristic symptoms of yellow leaf syndrome (YLS) in 66 different sugarcane varieties/clones in Tamil Nadu, India, and also noticed disease incidences of 0 to 75.0% in farmer fields. Madugula and Devi G (2018) detected ScYLV in YLD-infected samples, and the presence of both SCYLV and SCMV (*Sugarcane Mosaic Virus*) in mixed infection was confirmed by electron microscopy in different samples collected from Andhra Pradesh and Telangana.

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Pokkah boeng (PB)

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The incidence of Pokkah boeng was noticed on many varieties, i.e., Co 99004, Co 86032, Co C 671, Co JN 86-141, Co 85004, CoSnk 3632, Co 0238, CoS 88230, Co 92005 and Co M 265. The disease was prevalent in all the surveyed locations, with low to moderate incidence during three years of the survey. The **high** incidence was recorded in Co 99004, i.e. 5-13 and 5-23% at Narmadapuram and Bohani, respectively. It was also comparatively higher in Co C 671 (4-**13** %) at Bohani. The symptoms of Pokkah Boeng affected plant showed curling/twisting of spindle leaves, tearing of leaves, and chlorotic streaks on the leaves at varying intensities. In severe infection, a malformed or damaged top and stalk were noticed (Figure 1). Previously, Pokkah boeng disease of sugarcane mainly occurred in Maharashtra and Uttar Pradesh, but in recent years, it has also been observed in Madhya Pradesh. Patil and Hapase (1987) recorded a high severity of pookah boeng disease in two commercial varieties in Maharashtra. Vishwakarma *et al.* (2013) also found an increasing trend of Pokkah boeng in most commercial cultivars, with a 1-90 per cent incidence in Uttar Pradesh.

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Sugarcane mosaic

Incidence of sugarcane mosaic was noticed in Co 7219 (up to 15 %), Co 86032 (up to 8 %), CoC 671 (up to 17 %), and Co 94008 (up to 20 %) at Narmadapuram during 2014 and 2015 (table 1). Interveinal chlorotic specks, streaks or stripes in young and rapidly growing leaves with contrasting shades of green patterns were noticed on the affected plant (Figure 1). Viswanathan and Karuppaiah (2010) revealed the prevalence of mosaic and yellow leaf diseases in most of the varieties in Indian conditions. Viswanathan (2012, 2013) suggested that poor performances in older varieties or “varietal degeneration” have occurred due to infections of pathogens causing YL, RSD and mosaic in India. A recent survey in the North Coastal districts of Andhra Pradesh indicated a high range (15-35 %) of sugarcane mosaic incidence (Varma et al., 2020).

Red rot

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Red rot was observed after the rainy season in September on CoS 88230, Co Lk 8001/Unknown, Co C 671, Co 8014, and Co J 64. In 2014 and 2015, the incidence of red r was very low, and only two varieties were found to be affected. A 2019 survey found red rot in some other varieties growing in Kareli and Bohani. Red rot incidence was ranged between 2 to 13 %. During the survey, plants exhibited yellowing and drying of third and fourth leaves, followed by drying of entire leaves and later stalks became discoloured. After splitting, the internal tissues showed reddening intermingled with transverse white patches (Figure 1). In India, red rot was a major devastating sugarcane disease in the past. According to Viswanathan and Rao (2011), red rot remains the primary sugarcane disease, followed by wilt and smut, the other essential diseases seriously affecting cane production in India. Currently, red rot disease occurs at varying intensities in most of the sugarcane-growing states in India (Viswanathan, 2012). Anuradha et al. (2019) reported varying intensity of red rot in different sugarcane genotypes in Punjab.

Sugarcane wilt

The wilt incidence was observed on Co J 64 and Co 94012 at Tendukheda, Bankhedi, Kareli, Gadarwara and Bohani locations. Among varieties, the incidence ranged between 0-20 % in CoJ 64 and 11-33 % in Co 94012, respectively (table 1). The symptoms were recognized during September. The wilt-infected plants initially showed yellowing of the top leaves. In the later stage, the clump dried; the cane became hollow and lighter in weight, and red discolouration in internodes became more intense (Figure 1). Viswanathan *et al.* (2006) reported a higher wilt incidence in tropical states such as Gujarat, Tamil Nadu, Andra Pradesh and Orissa. In contrast, low incidence in subtropical Indian states such as Uttarakhand and Madhya Pradesh. Previous surveys also reported that wilt was one of the diseases prevalent in M.P. (Singh et al., 2007). However, its incidence has comparatively increased in recent years.

Conclusion

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Surveys revealed that all the common diseases that appear in different parts of the country have also been noticed in Madhya Pradesh. The incidence of seven diseases has been noticed. Sugarcane smut was found to be a significant disease affecting most of the sugarcane varieties growing at varying intensities. Growing non-recommended varieties, multiple ratooning, and lack of knowledge of seed health have played critical roles in disseminating sugarcane disease in the state.

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Table 1 Incidence of naturally occurring disease on sugarcane in Madhya Pradesh during cropping season of 2014-15, 2015-16 and 2019-20

Diseases	Locations	Varieties	Per cent incidence		
			2014	2015	2019

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Smut (15 th May to 15 th June)	Narmadapuram	Co 99004	2-7	1-4	-
		Co 86032	3-8	2-3	-
		Co C 671	1-3	-	2-3
		Co 7219	9-11	7-10	-
	Bankhedi	Co M 265	2-3	-	1-5
		Co 86032	2-3	2-4	3-5
		Co J 64	6-10	4-7	3-18
		Co 0238	4-6	3-4	5-7
	Kareli and Gadarwara	Co J 64	5-11	4-11	5-13
		Co M 265	1-3	-	1-5
		Co 80-14	-	6-10	5-12
		Co 94012	-	5-9	4-5
	Amla/Betul	Co 86032	4-7	3-5	-
		Co 62175	3-6	2-4	-
		Co C 671	1-2	1-2	-
	Bohani	Co J 64	-	-	3-18
		Co 92005	-	-	3-5
		Co 94012	-	-	5-8
		Co 0238	-	-	1-5
		Co 86032	-	-	3-5
Co 92004		-	-	2-5	
Grassy shoot disease (GSD) (10-30 th July)	Narmadapuram	Co 86032	1-3	1-4	0-3
		Co 7219	2-5	-	-
		Co C 671	1-2	0-2	1-2
	Bankhedi	Co 86032	1-4	1-5	0-3
		Co C 671	2-3	-	1-4
		Co J 64	4-5	-	5-7
	Kareli	Co 86032	1-3	2-3	1-3
		Co J 64	5-6	3-5	4-6
	Bohani	Co C 671	-	-	1-3
		Co 86032	-	-	2-5
		Co J 64	-	-	5-11
	YLDS (10-30 th July)	Narmadapuram	Co 99004	0-10	0-4
Co 86032			0-1	0-1	1-4
Kareli		Co 86032	0-1	0-1	1-2
		Co J 64	2-3	-	3-6
		CoVSI 434	-	0-10	0-3

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	Bankhedi	CoS 88230	-	0-3	-
		Co C 671	0-1	-	1-2
		Co J 64	1-3	-	-
	Bohani	Co 99004	-	-	3-7
		Co J 64	-	-	2-4
Pokkah Boeng (10-30 th July)	Narmadapuram	Co 99004	5-13	0-5	1-3
		Co C 671	3-8	0-3	1-5
		Co 86032	3-6	0-1	2-5
		Co 85004	2-5	0-1	-
		Co JN 86-141	1-3	-	1-4
	Tendukheda	Co 86032	2-4	-	3-5
	Bankhedi	Co 0238	2-5	0-5	2-6
		Co 86032	3-6	0-1	1-3
	Kareli	Co 86032	4-6	-	3-4
		Co M 265	2-5	0-3	1-3
		CoS 88230	-	0-3	0-5
	Bohani	Co 86032	-	-	3-7
		Co C 671	-	-	4-13
		Co 85004	-	-	1-5
		CoSnk 3632	-	-	3-7
		Co 0238	-	-	5-7
		Co 92005	-	-	3-5
		Co 99004	-	-	5-23
	Co JN 86-141	-	-	2-3	
Mosaic (10 to 30 th September)	Narmadapuram	Co 7219	10-15	7-13	-
		Co 86032	2-7	5-8	-
		CoC 671	8-12	10-17	-
		Co 94008	-	4-20	-
Wilt (10 to 30 th September)	Tendukheda	Co J 64	0-10	-	3-9
	Bankhedi	Co J 64	0-20	-	2-7
	Kareli & Gadarwara	Co 94012	-	10-25	9-30
		Bohani	Co 94012	-	-
		Co J 64	-	-	7-17
Red rot (10 to 30 th September)	Kareli	CoS 88230	-	2-3	3-5
		Co Lk 8001/Unknown	-	5-12	4-10

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		Co C 671	-	-	5-11
		Co 8014	-	-	6-13
	Bohani	Co J 64	-	-	6-11
		Co C 671	-	-	5-13
		Co Lk 8001/Unknown	-	-	7-11

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Figure 1. Symptoms of sugarcane diseases observed during survey: whip smut (A), Grassy shoot disease (B), Pokkah Boeng (C), Red rot field (D), Red rot affected cane (E and F), wilt affected cane with reddened internal tissue cavity formed (G), Sugarcane mosaic (H), and yellowing leaf disease (I), respectively.

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