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The incidence of pokkah boeng in indigenous and exotic sugarcane (*Saccharum officinarum*) clones

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ABSTRACT

Pokkah boeng (*Fusarium moniliforme* J L Sheldon) is a minor fungal disease in sugarcane (*Saccharum officinarum* L.), characterized by malformed leaves. The disease incidence was surveyed at two locations in Haryana (Karnal and Kaithal) from 2010 to 2013. Chlorotic phase infection was prevalent in the study area. The percent disease incidence ranged from 6.90 to 25.30%, the highest incidence was recorded during 2013. A total of 138 subtropical sugarcane varieties, 40 pre-release clones and 182 exotic clones were screened against the disease under natural epiphytotic condition at Karnal. Most of the clones (80.83%) were resistant (120 clones out of 360) or moderately resistant (171 clones out of 360) to pokkah boeng. Subtropical varieties such as BO 137, Co 0238, CoH 110, CoJ 83, CoJ 85, CoS 8432, CoS 8436, CoS 88230, CoS 03251, CoS 03252, CoSe 95436, CoSe 01434 and UP 0097 were moderately susceptible hence strong seed health programme is suggested to contain the disease. Fourteen clones, viz. Co 425, Co 12027, Co 10036, Co 0331, M 165/38, H 45-2120, B 46-199, Q 64, PR 1058, CP 81-1384, F 65-554, POJ 6688, EPC 37-069 and H 44-3098 were susceptible to pokkah boeng hence this information may be taken into account while deciding the merit of the clones for hybridization. Autumn planted canes manifested less disease incidence than spring planted canes. Canes around field border and broad leaved clones showed higher disease incidence. However, the incidence did not vary between plant crop and ratoon crops. There were no association between pokkah boeng incidence and top borer attack but their combined damage would be detrimental to the crop. About 92.67% of pokkah boeng infected plants recovered growth, without fungicide spray, as the age of the crop advances and with change in weather.

Key words: Pokkah boeng, Screening sugarcane germplasm, Subtropical India

Pokkah boeng is a monsoon season foliar disease caused by the fungus *Fusarium moniliforme* J L Sheldon. The disease was noticed in the tropical states like Maharashtra when varieties such as Co 7219 and CoC 671 were grown in large scale (Patil and Hapase 1984, Viswanathan and Padmanaban 2008). In the subtropical states like Haryana, pokkah boeng incidence was reported way back in 1997 by Singh and Virk (1997) but serious attention was not shown as the disease was of minor importance. In recent years, widespread incidence of the disease was noticed in the subtropical states. Chlorotic phase of infection was common in subtropical region but top rot phase was reported in Kaithal and Shahabad districts (Haryana) and knife-cut phase in Maizapur (UP). In this context, the study was undertaken to assess the extent of pokkah boeng incidence in subtropical varieties, pre-release clones and exotic germplasm and to observe the effect of season, crop type, field position on disease incidence. Self recovery of pokkah boeng infected plants without fungicide spray was also observed.

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MATERIALS AND METHODS

The disease incidence was monitored in two cane varieties namely, Co 0238 and CoS 8436, at two locations in Haryana, i.e. at Sugarcane Breeding Institute, Regional Centre, Karnal and farmers' fields in the village Budhakhera (District Kaithal) for four years from 2010 to 2013. At each location, 3×100 stalks per variety were randomly selected during August. The number of infected and healthy stalks was counted and per cent disease incidence was worked out.

Three kinds of germplasm were screened against the natural incidence of pokkah boeng at Karnal as detailed below. (1) *Released varieties*: 138 subtropical sugarcane varieties (listed in Table 1) were planted during Feb 2010, Feb 2012 in RBD with three replications and again during Feb 2013 in augmented design. (2) *Pre-release clones*: 40 Co canes evolved at SBI Regional Centre, Karnal (list given in Table 1) were planted in RBD with two replications during October 2009, March 2010 and March 2011. (3) *Exotic clones*: 183 foreign hybrids were screened in phased manners, i.e. 28 clones were planted during March 2010, another 28 clones were planted during March 2011, 60 clones during March 2012 and 66 clones during March 2013. These trials were laid out in RBD with two replications.

The plot size for the trials was 2 rows of 6 m length spaced at 0.9 m between rows. The crop was raised following the recommended package of practices for the state of Haryana. The number of infected stalks to the total stalks was counted clone-wise during August of every year and percent disease incidence was worked out. On the basis of percent disease incidence the clones were grouped into five resistant categories following the classification suggested by Gulya *et al*. (1980). The rating scale given below is also followed by the scientists at Shakarganj Sugar Research Institute, Jhang for testing sugarcane clones against pokkah boeng.

Pokkah boeng infected stalks	Resistant category
0-1 %	Resistant (R)
1-10 %	Moderately resistant (MR)
10-25 %	Moderately susceptible (MS)
25-50 %	Susceptible (S)
50-100 %	Highly susceptible (HS)

Observation on the incidence of top borer [*Scirpophaga nivella* (Fab.)], leaf length and leaf width were recorded in all the clones during August 2010. Simple correlation coefficient between percent disease incidence and leaf length, leaf width and top borer incidence was worked out.

Twenty 'Co' and Co allied clones, viz. Co 0118, Co 0121, Co 0124, Co 0237, Co 0238, Co 0239, Co 0241, Co 05009, Co 05011, Co 07023, Co 07024, Co 07025, Co 07026, Co 07027, Co 1148, Co 89003, Co 98014, CoJ 64, CoS 767 and CoS 8436 were planted in RBD with three replications during autumn (October 2009) and spring (March 2010). The plot size was 2 rows × 6m × 0.9m. The percent disease incidence in each clone and each season was observed during August. The data was analyzed through factorial RBD after angular transformation.

The farmers' fields in the village Budhakhera of District Kaithal (Haryana) was selected for the study. Four varieties namely, Co 0238, CoH 119, CoS 8436 and CoJ 64 were chosen in such a way that its plant crop and ratoon were available adjacent to each other. A total of 3×100 stalks were randomly selected from each variety and from each crop type (plant and ratoon). The percent disease incidence recorded on plant and ratoon crops during August 2010. The data was analyzed after angular transformation.

Three isolated seed cane plots (30m × 60m) of the variety Co 0238, surrounded by 4.5 m vacant space around each plot were selected for the study during 2010. The number of pokkah boeng infected stalks and total stalks in four borders (i.e. plants lying in 2 rows or 1.8 m width strips in four side of a field) was counted during August 2010. The number of infected stalks was also counted at four locations interior in the field. The percent disease incidence in field border and field interior was compared. The study was repeated again during 2013-14 crop season.

To investigate whether pokkah boeng infected plants self-recover or not without fungicide application, 3×100 pokkah boeng infected plants of the variety Co 0238 were tagged during June 2010. At the end of September 2010, the newly emerged leaves in these plants were examined for the presence of pokkah boeng symptoms. The number of infected plants that were free from fresh infection at the end of September and grow as healthy cane was counted and expressed in percentage.

RESULTS AND DISCUSSION

Phase of infection: Pokkah boeng infection has three phases namely, chlorotic, acute and knife-cut phases (Patil *et al.* 2007). In the study area in Haryana chlorotic phase infection was recorded from 2010 to 2013, except in one field at Budhakhera where top rot was recorded during August 2010 in a few plants of the varieties CoS 8436 and CoJ 85. The earliest symptoms of pokkah boeng in Karnal was the appearance of chlorotic spots and patches at the base of young leaf lamina during June 1st week, followed by distortion like wrinkling and twisting of leaves. During rainy months (July-August) which coincide with grand growth phase of sugarcane, reddish stripes developed within the chlorotic area. Disintegration and partial breaking of leaf tissues was also observed. The newly emerged spindle leaves become shortened giving small sword or spindle apearance.

The extent of pokkah boeng *in Haryana:* The percentage of pokkah boeng infected stalks in Karnal ranged from 21.1 to 22.1% (mean 21.6%) during 2010, 10.8 to 12.6% (mean 11.7%) during 2011, 8.0 to 13.5% (mean 10.7%) during 2012 and 17.4 to 24.1% (mean 20.8%) during 2013 (Fig 1). At Kaithal the disease incidence varied from 14.6 to 18.1% (mean 16.4%) during 2010, 6.9 to 10.2% (mean 8.6%) during 2011, 12.8 to 13.3 % (mean 13.1%) during 2012 and 18.3 to 25.3% (mean 21.8%) during 2013 (Fig 2). Of the four crop season from 2010 to 2013, 2010 and 2013 were the years of high pokkah boeng incidence in Haryana (pokkah boeng incidence at two locations, in two varieties was 18.96% in 2010 and 21.29% in 2013). During the years 2011 and 2012 relatively less incidence (10.12% during 2011 and 11.89% during 2012) were recorded. The incidence of pokkah boeng observed in the study (specifically during 2010-13) was higher than earlier reports of less than 10% by Singh and Virk (1997) in Haryana and Singh *et al.* (2006) in Uttar Pradesh. Pokkah boeng although a minor disease in India, it is spreading at higher intensity in Haryana and adjoining States. Whenever, the incidence goes high, farmers may be advised to go for foliar spray with 0.1% Carbendazim or 0.1% Copper oxychloride during June-July or depending upon the appearance of disease symptoms.

Reaction of sugarcane clones: The tall stature and crowded canopy of sugarcane makes fungicide spray more difficult during grand growth phase. Therefore, resistant breeding is looked as a practical and effective way of managing sugarcane diseases including pokkah boeng. In the study different kinds of germplasm were screened against pokkah boeng under natural epiphytotic condition. In the first category of germplasm comprising of 138 released varieties the disease incidence over years (2010-13) was 0.0 to 39.94%. Twenty eight varieties showed less than 1%

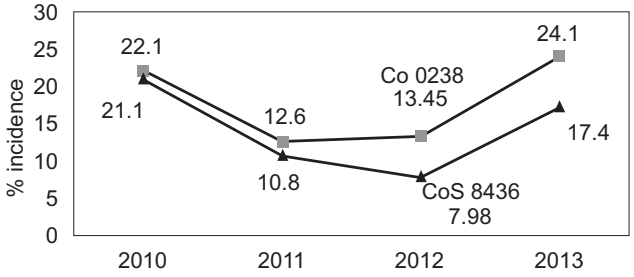

Fig 1 Incidence of pokkah boeng at Karnal from 2010 to 2013

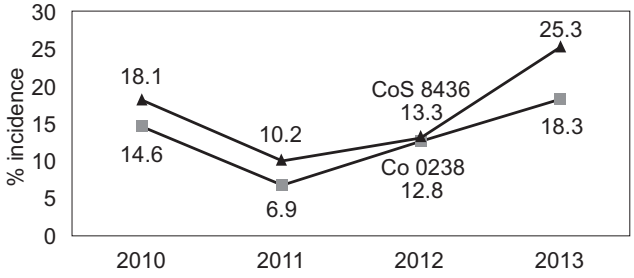

Fig 2 Incidence of pokkah boeng at Kaithal from 2010 to 2013

pokkah boeng incidence, hence they were classified as 'resistant (R)' varieties (Table 1). In another 96 varieties, the disease incidence ranged from 1.0 to 10.0% hence classified as 'moderately resistant (MR)' varieties. In another 13 varieties, the incidence was between 10.1 and 25.0% hence they were classified as 'moderately susceptible (MS)' varieties. Only one variety, i.e. Co 6425 belongs to 'susceptible (S)' category (25.1 to 50.0% incidence). In the

Table 1 Classification of sugarcane clones according to their reaction against pokkah boeng under natural epiphytotic condition at Karnal

Resistant clones (0-1% disease incidence)

Released varieties (28 var.): BO 141, BO 145, BO 147, BO 153, Co 0124, Co 0237, Co 6617, CoBln 02173, CoBln 9006, CoBln 94063, CoH 128, CoLk 7901, CoP 2061, CoPant 03220, CoPant 90222, CoPant 96219, CoS 07250, CoS 01256, CoS 02264, CoS 245, CoS 443, CoS 514, CoS 90265, CoS 96275, CoS 97258, CoS 99259, CoSe 01235 and UP 05125.Advanced pipeline clones (13 clones): Co 0116, Co 0122, Co 0123, Co 0327, Co 06037, Co 07028, Co 10035, Co 10037, Co 11027, Co 12026, Co 13034, Co 13035 and Co 0424.

Exotic clones (79 clones): Argentina, B29-35, B33-54, B33-65, B39-274, B40-105, B41-203, B41-242, B41-248, B41-45, B42-261, B43-229, B43-238, B45-151, B45-18, B45-24, B47-258, BN111, BN74, BO186, C278, CP1165, CP31-511, CP33-243, CP33-310, CP36-111, CP43-33, CP43-44, CP43-47, CP44-155, CP50-11, CP53-18, CP63-354, CP72-2086, EPC 37-082, EPC 37-207, EROS, F133, F31-450, H52-246, H53-263, KM674, KM86, LF61-52, LF61-5257, LF62-986, LF63-1617, LF65-119, LF65-3705, LF65-4329, LF65-5943, LF68-3866, LF69-713, LF69-814, LF70-920, LF74-4010, M171/30, M73/39, NCo 151, POJ 290, POJ 2961, POJ 3067, Pomex 60, Pomex 85, PR1039, PR1044, PR1049, PR1050, PR1069, PR1085, PR908, PRB, PT 45-52, PT46-1023, Q45, SP80-1816, SW111, US16-94 and Yasawa.

Moderately resistant (1-10%)

Released varieties (96 var.): CoLk 94184, UP 9530, CoS 109, UP 5, CoP 9302, CoPant 90223, CoJ 88, BO 130, CoS 770, Co 89003, CoSe 98231, CoPant 84212, CoSe 92423, BO 128, BO 110, CoS 97248, CoSe 01424, CoBln 9105, Co 0118, CoS 96268, CoS 95255, CoS 94270, CoS 767, Co 89029, BO 99, BO 129, CoS 93259, CoS 95222, CoS 97264, CoS 8207, CoS 687, CoP 9301, CoLk 8102, CoS 97261, CoLk 8001, Co 05011, CoS 02258, CoH 99, CoJ 89, BO 138, CoPant 99214, Co 6811, Co 87268, BO 91, CoSe 96436, CoS 00257, CoS 01235, BO 109, CoB 94164, BO 120, CoS 96269, CoH 160, CoPant 97222, Co 0239, CoH 92, CoS 03279, Co 7717, CoS 8118, CoH 56, CoS 8315, CoH 35, CoBln 9102, CoSe 95422, BO 146, BO 136, CoP 9206, CoPant 08221, CoPant 84211, CoS 03261, CoS 95270, CoS 541, CoS 94257, CoS 98259, BO 139, Co 1148, Co 453, Co 0237, CoS 96258, CoS 797, Co 87263, CoP 9702, CoS 91230, Co 1158, CoS 90269, Co 1336, CoS 7918, CoSe 00235, CoBln 9101, CoBln 9104, CoJ 64, CoS 510, CoS 91269, CoH 119, Co 98014, CoBln 9103 and Co 419.

Advanced pipeline clones (19 clones): Co 06035, Co 09022, Co 07026, Co 05009, Co 06034, Co 07025, Co 10039, Co 06036, Co 07027, Co 07022, Co 07024, Co 05010, Co 11026, Co 12028, Co 06033, Co 06032, Co 07023, Co 0241 and Co 0240.

Exotic clones (56 clones): KT 730, PR 1000, CP 57-614, FB 37-172, Yuetang 85-177, Ragnar, M112/34, POJ 279, B7-39, B44-52, TUC 521, Q69, H59-5, BT379, LF61-666, CP377, F31-762, PR1085, CP31-355, HBA124, PR1054, CPC87, BM368, POJ 228, B44-116, CL41-142, KM724, KT367, B43-337, PR1028, Mali, LP64-2815, H59-3775, B34-12, F108, CL61, OB40-47, PT33-86, Q27, BO212, H53-1447, LF70-1151, Q65, H50-7000, CP78-2114, Q50, H41-3340, B40-47, PR1042, L62-37, Q73, B208, PR1080, CP79-318, Uba Marrot and I1081.

Moderately susceptible (10-25%)

Released varieties (13 varieties): CoS 88230, CoSe 95436, CoJ 83, CoH 110, CoS 8436, CoS 8432, CoJ 85, CoSe 01434, BO 137, UP 0097, CoS 03251, CoS 03252, and Co 0238.

Advanced pipeline clones (5 clones): Co 09021, Co 13033, Co 13036, Co 09020 and Co 0121.

Exotic clones (37 clones): PR1084, L61-43, Q48, CP53-99, CP36-13, D166/37, H44-2772, PR1028, D419/33, C15-792, POJ 2753, H38-2915, EPC37-028, F134, POJ 2883, C47-72, B40-175, Mana, PR1081, CAC87, AJ2961, LF52-2402, CP80-1827, PR1047, Q62, F31-407, CP70-1133, PR1083, EK28, LF68-7639, PR904, CP31-588, H56-5174, Mole251 and CP56-519.

Susceptible (25-50%):

Released varieties (1 var.): Co 6425.

Advanced pipeline clones (3 clones): Co 12027, Co 10036 and Co 0331.

Exotic clones (10 clones): M 165/38, H45-2120, B46-199, Q64, PR1058, CP81-1384, F65-554, POJ 6688, EPC37-069 and H44-3098.

Highly susceptible (>50%)

Nil

Note: Clones are arranged in their increasing order of pokkah boeng incidence.

second category of germplasm with 40 advanced pipeline clones, the disease incidence ranged from 0.0 to 38.54%. Thirteen clones were R to pokkah boeng, 19 were MR, 5 were MS and 3 were S (Table 1). In the third category of germplasm constituted by 182 exotic clones the disease incidence varied from 0 to 48.21%. Seventy nine clones were classified as R to pokkah boeng, 56 were MR, 37 were MS and 10 were S (Table 1). From the results it is clear that a large proportion of clones (80.83%) had innate resistance (either R or MR) to the disease and only a small proportion (14 out of 361 clones) were susceptible. Special mention must be made that none of the clones were highly susceptible to pokkah boeng with >50% disease incidence. The susceptible clone Co 6425 was already withdrawn from cultivation while other susceptible clones such as Co 12027, Co 10036, Co 0331, M 165/38, H 45-2120, B 46-199, Q 64, PR 1058, CP 81-1384, F 65-554, POJ 6688, EPC 37-069 and H 44-3098 did not attain varietal status. Therefore, the susceptible clones will not contribute to further spread of the disease in the subtropical zone. But, as a precautionary measure these clones may be excluded in the hybridization programme. Exclusive breeding programme against pokkah boeng may not be required as of now, nevertheless attention must be given while multiplying the seeds of MS varieties such as BO 137, Co 0238, CoH 110, CoJ 83, CoJ 85, CoS 8432, CoS 8436, CoS 88230, CoS 03251, CoS 03252, CoSe 95436, CoSe 01434 and UP 0097. Since these varieties were MS to pokkah boeng and are still in cultivation in the subtropical states, a strong seed health programme like three-tier seed nursery is recommended. Seed cane of these varieties must be obtained from pokkah boeng free region or healthy fields.

Effect of season (autumn and spring planting): In autumn planting, the disease incidence ranged from 0.0 to 18.39% and the mean was 4.82% (Table 2). In spring planting, the incidence ranged from 1.04% to 27.12% and the mean was 9.29%. Spring planting manifested 0.36 to 11.07% higher pokkah boeng incidence than the autumn planting. Clones such as Co 07024, Co 07027, Co 89003 and CoS 767 planted during autumn were free from infection whereas spring planted crop of these clones had 5.26%, 5.87%, 5.81% and 1.04% pokkah boeng incidence, respectively. From the study, it was evident that the age of the crop also influenced the intensity of pokkah boeng. Young crops which are in the transition stage from tillering phase to grand growth phase have succumbed higher infection than aged crop. October planted autumn crop has four months of age advantage than the February planted spring crop. This chronological difference perhaps could attribute to the difference in pokkah boeng incidence in autumn and spring crop. Similar observation was made by McFarlane and McFarlane (2002) on the incidence of sugarcane smut in Natal, South Africa. Varieties such as Co 0121, CoS 8436 and Co 0238 were harbouring relatively higher load of pokkah boeng pathogen in both the seasons. Therefore, precautionary measures such as prophylactic spray with Carbendazim @ 0.1% may be resorted as and when the symptoms are observed in the field.

Table 2 Percent incidence of pokkah boeng in autumn and spring planted crops

Clones	Autumn plantedcane	Spring planted cane	Difference between season
Co 0118	3.27 (10.41)	7.88 (16.29)	–4.61
Co 0121	16.06 (23.61)	27.12 (31.37)	–11.07
Co 0124	0.49 (4.01)	6.55 (14.83)	–6.06
Co 0237	7.26 (15.62)	15.75 (23.37)	–8.49
Co 0238	18.39 (25.38)	18.75 (25.65)	–0.36
Co 0239	6.25 (14.47)	6.75 (15.05)	–0.50
Co 0241	1.45 (6.90)	10.37 (18.78)	–8.92
Co 05009	0.38 (3.51)	2.11 (8.35)	–1.74
Co 05011	0.71 (4.81)	2.89 (9.78)	–2.18
Co 07023	1.78 (7.67)	10.58 (18.97)	–8.79
Co 07024	0.00 (0.91)	5.26 (13.25)	–5.26
Co 07025	0.78 (5.05)	3.02 (10.00)	–2.24
Co 07026	0.92 (5.50)	2.61 (9.29)	–1.69
Co 07027	0.00 (0.91)	5.87 (14.01)	–5.87
Co 1148	11.22 (19.57)	12.54 (20.73)	–1.32
Co 89003	0.00 (0.91)	5.81 (13.95)	–5.81
Co 98014	4.36 (12.05)	9.56 (18.01)	–5.21
CoJ 64	7.28 (15.64)	8.74 (17.19)	–1.46
CoS 767	0.00 (0.91)	1.04 (5.85)	–1.04
CoS 8436	15.91 (23.50)	22.70 (28.44)	–6.79
Mean	4.82 (12.65)	9.29 (17.74)	–4.47
CD (P=0.5) for varieties	(7.46)	(7.12)	CD b/w seasons= 1.66

Note: Values within the bracket are angular transformed values

Effect of crop type (plant and ratoon): Certain air borne fungal disease (like sugarcane smut) causes more damage in ratoon crop than in the plant crop (Sabalpara and Vaishnav 2002). To know whether pokkah boeng infection exhibits such behaviour this study was undertaken. The mean disease incidence in plant crop of four varieties was 8.19% while it was 7.27% in ratoon crop (Table 3). The difference was not significant thereby indicating that incidence of pokkah boeng was not influenced by crop type (plant or ratoon).

Effect of position (field border and interior): Unequal spatial distribution (within a field) of certain insect pests and pathogens was reported by Grinsteine *et al.* (1995),

Table 3 Percent incidence of pokkah boeng in plant and ratoon crop at Budhakhera village, Kaithal during 2010

Varieties	Plant crop	Ratoon crop	Difference between season
Co 0238	10.03 (18.46)	12.19 (20.43)	–2.16 (8.45)
CoH 119	3.81 (11.25)	2.45 (9.00)	1.36 (6.69)
CoS 8436	13.43 (21.49)	10.94 (19.31)	2.49 (9.07)
CoJ 64	5.48 (13.53)	3.49 (10.76)	1.99 (8.11)
Mean	8.19 (16.62)	7.27 (15.64)	0.92 (5.50)

Values within bracket are angular transformed value; CD for crop type was NS

Bock and Jeger (2002) and Boiteau (2005). Pokkah boeng is an airborne disease, the conidia of *Fusarium moniliforme* carried away from one place to another through air currents (Martin *et al.* 1989) hence at times spatial variation in inoculums or disease intensity is expected. On this presumption, this study was conducted to test whether pokkah boeng incidence vary from field border to interior. In the study, the incidence of pokkah boeng in field border was 20.43% in 2010 and 25.63% in 2013 which were 6.38% to 10.13% higher than the percent disease incidence recorded in interior of the field during 2010 (13.36%) and 2013 (15.50%). The differences were significant statistically (CD=6.36). The disease incidence recorded on border rows were further partitioned into Northern, Southern, Eastern and Western sides of field. The mean data of 2010 and 2013 showed that the pokkah boeng incidence did not vary significantly from one border direction to another (Table 4). But, year-wise data indicated that higher disease incidence in specific borders. For example, in 2010 the Western (26.34%) and the Northern borders (22.39%) and in 2013 the Eastern (33.58%) and the Southern (30.21%) borders exhibited higher disease incidence which could be attributed to the greater vacant space (8-10 m) adjacent to these borders as compared to narrow vacant space (4.5 m) in other sides. In Karnal, wind flows from North-West during April-May and from South-East during June-July. The prevailing air current did not make significant difference on the intensity of disease incidence between windward and leeward direction, but it is certain that if field border has greater vacant space adjacent to it, the disease incidence was higher in that side.

Association between pokkah boeng and top borer: McFarlane and Rutherford (2008) reported that some isolates of *Fusarium moniliforme* were beneficial to sugarcane stalk borer *Eldana sachharina* while others were antagonistic. Data on number of pokkah boeng infected plants also infested with top borer (*Scirpophaga nivella*) was recorded on 138 subtropical varieties during 2010. Thirty varieties succumbed both to pokkah boeng infection and top borer infestation. Others were free from top borer infestation. In the 30 top borer affected varieties, infestation was in the range of 1.49% in CoS 8436 to 56.25% in CoS 510. Higher top borer incidence was found in CoS 109 (56.25%), CoS 541 (44.44%) and CoS 797 (36.84%) and low infestation was recorded in Co 6425 (1.67%), CoS 8432 (3.77%) and Co 419 (4.35%). Comparative analysis of percent incidence of pokkah boeng and percent incidence of top borer revealed no definite trend of association between these two factors. Varieties such as CoS 109, CoPant 90223, BO 110, CoS 97264, CoP 9206, BO 128, CoLk 8102 had low incidence of pokkah boeng (<5.0%) and high incidence of top borer (10.0-14.3%). Conversely, varieties such as Co 0238, CoS 88230, Co 98014 and CoSe 95436 had high incidence of pokkah boeng (10.0-20.8%) and less incidence of top borer (<10.0%). This trend is also supported by non-significant correlation coefficient (r=0.12) between percent incidence of pokkah boeng and percent incidence of top borer. It is to be noted that the combined effects of pokkah boeng and top borer will be more detrimental to the growth and yield of sugarcane hence, it is necessary to take precautionary measure to control top borer and pokkah boeng in such varieties.

Table 4 Incidence of pokkah boeng in field border and interior in Co 0238 during 2010 and 2013

Field position	Border direction	2010	2013	Mean
Field borders	Southern side	15.61 (9.09)	30.21 (33.33)	22.91 (28.58)
	Northern side	22.40 (12.92)	19.51 (26.20)	20.95 (27.23)
	Eastern side	14.76 (18.43)	33.58 (34.50)	24.01 (29.33)
	Western side	28.94 (32.53)	19.23 (26.00)	24.08 (29.37)
	Mean	20.43 (29.86)	25.63 (30.40)	23.03 (28.67)
CD (P=0.5) among borders		NS	6.67	NS
Field interior	Mean	13.36 (21.41)	15.50 (23.17)	14.10 (22.05)
CD (P=0.5) for border interior		7.41	7.23	2.84

t-value for pooled border *vs*. interior at p.0.5=5.35, P(T<=t) two-tail=0.00

Figures in parenthesis are the angular transformed values.

Pokkah boeng versus leaf morphology: To investigate the effect of leaf length and leaf width on pokkah boeng incidence, 102 indigenous and 98 foreign clones of varying leaf morphologies were chosen. Observation on leaf length, leaf width and pokkah boeng incidence were recorded. The association between pokkah boeng incidence and leaf length was non-significant (r=0.08), whereas leaf width showed significant positive correlation (r=0.34). To illustrate further that the pokkah boeng incidence was higher in broad leaved varieties, these clones were grouped into three categories, viz. narrow, medium and broad. The range of pokkah boeng incidence in each category is presented in Table 5. In narrow leaved clones, the disease incidence did not exceed 10%, whereas in medium and broad leaved clones the incidence reached up to 35.71 to 39.94% respectively. The number of clones exhibiting >10% pokkah boeng incidence increased as leaf width increased from medium to broad (Table 5). This result is supportive of Singh *et al.* (2006) who reported that broad leaved varieties like CoS 8436 and CoS 88230 had higher pokkah boeng infection.

Self-recovery of pokkah boeng infected plants: The vegetative parts of some host plants infected by mild strain of pathogen often recover during its further growth or under changing weather as seen in Olive infected by *Verticillium* (Rodriguez *et al.* 1993). In the present study, it was observed that 92.67% of pokkah boeng infected plants regained from the biotic stress during August-September and resumed normal growth without fresh infection in the newly emerged leaves, thus giving evidence for the presence of self-recovery

Table 5 Incidence of pokkah boeng in clones of different leaf width group

Leaf width category	No. of clones examined	Range and (mean) of pokkah boeng incidence	Percentage of plants with >10% pokkah boeng incidence
Narrow (<3.0 cm)	14	0.0 - 7.96% (4.25%)	0.00
Medium (3.0-5.0 cm)	148	0.0 - 39.94% (7.24%)	21.62
Broad (>5.0 cm)	44	2.17 - 35.71% (10.37%)	36.36

mechanism in host plants.

Observations from various field trials conducted at Sugarcane Breeding Institute, Regional Centre, Karnal from 2010 to 2013 showed that if chlorotic phase infection alone was present during monsoon season it would disappear during post-monsoon period, with change in crop age and weather. Therefore, farmers need not worry as long as the chlorotic phase infection alone prevails and disease incidence at less intensity (<25% of the plants). However, precautionary measures would be necessary if the top rot phase infection is seen even in small patches or the intensity and incidence of chlorotic phase infection shoots up. Foliar application of Carbendazim and Streptocyclin during June would be effective to mange top rot phase infection.

REFERENCES

Bock C H and Jeger M J. 2002. The distribution and spread of sorghum downy mildew in sorghum and maize fields in Nigeria and Zimbabwe. *European Journal of Plant Pathology* **108**(8): 745–53.

Boiteau G. 2005. Within-field spatial structure of Colorado potato beetle (Coleoptera: Chrysomelidae) populations in New Brunswick. *Environmental Entomology* **34**(2): 446–56.

Grinstein A, Kritzman G, Hetzroni A, Gamliel A, Mor M and Katan J. 1995. The border effect of soil solarization. *Crop Protection* **14**(4): 315–20.

Gulya T J, Jr Martinson C A and Loesch P J Jr. 1980. Evaluation of inoculation techniques and rating dates for *Fusarium* ear rot of opaque-2 maize. *Phytopatholgy* **70**: 1 116–8.

Martin J P, Handojo H and Wismer C A. 1989. Pokkah boeng. *Diseases of Sugarcane. Major Diseases*, pp 157–68. Ricaud C, Egan B T, Gillaspie Jr and Hughes C G (Eds). Elsevier Science Publishers B V, Amsterdam.

McFarlane K and McFarlane S A. 2002. Improvements in the smut screening programme at the Pongola Research Station. (*In*) *Proceedings of Annual Congress of South African Sugar Technologists' Association,* pp 285–8, August 2002.

McFarlane S A and Rutherford R S. 2008. *Fusarium* species isolated from sugarcane and their effect on the development of the stalk borer *Eldana sachharina* Walker (Lepidoptera: Pyraulidae). *Journal of Plant Pathology* **90**(3): S79–S89.

Patil A S and Hapase D G. 1984. A new record of sugarcane disease in Maharashtra state. (*In*) *Proceedings of the Deccan Sugarcane Technologists Association,* pp 189–94, July 1984.

Sabalpara A N and Vaishnav M U. 2002. Screening of sugarcane clones/varieties for resistance to smut caused by *Ustilago scitaminea* Syd. *Indian Sugar* **52**(7): 507–9.

Singh A, Chauhan S S, Singh A and Singh S B. 2006. Deterioration in sugarcane due to *Pokkah boeng* disease. *Sugar Technology* **8**(2&3): 187–90.

Singh N and Virk K S. 1997. *Occurrence of Pokkah Boeng Disease on CoJ 64 in Yamunanagar Area*, pp 163–5. Dhawan A K, Chaudhary M K, Dendsey J P S and Dang Y P (Eds). CCS Haryana Agricultural University, Hissar.

Viswanathan R and Padmanaban P. 2008. *Handbook on Sugarcane Diseases and their Management*. Sugarcane Breeding Institute, Coimbatore, 72 p.


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