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Biochemical Changes in Total Sugars, Reducing and Non Reducing Sugars induced by *Colletotrichum falcatum* in Sugarcane

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ABSTRACT

Eight sugarcane varieties viz. Isd 2/54, Isd 5/55, Isd 16, Isd 18, Isd 19, Isd 20, Isd 21 and Misrimala are previously known red rot disease resistant, moderately resistant, moderately susceptible and susceptible to highly susceptible characteristic were selected and inoculated by spore suspension of mixed inoculum of red rot pathogen (*Colletotrichum falcatum*) for study post inflection biochemical changes of total sugars, reducing and non reducing sugars in sugarcane. Results revealed that total sugars and non reducing sugars in nodal tissues of inoculated canes decreased significantly irrespective of resistant and susceptible characteristics while reducing sugars significantly increased after 3, 6 and 12 d of inoculation compared to control. Total sugars decreased by 22.18 to 37.64% after 12 d inoculation. The lowest decrease was recorded in resistant variety Isd 19 while the highest in susceptible variety Isd 5/55. Reducing sugars of 8 varieties increased by 26.19 to 83.42%, while non reducing sugars reduced by 24.32 to 60.60% in inoculated canes compared to healthy canes (check). The rate of increase in reducing sugars and decrease in both non reducing and total sugars in inoculated canes were recorded higher in susceptible varieties compared to resistant varieties.

Key words : Red rot, *Colletotrichum falcatum*, biochemical changes, reducing and non reducing sugars.

INTRODUCTION

Various metabolites of host tissues suffer modifications in their composition by a pathogen and hence the nutritional value of the stored products is lowered (Tandon *et al.* 1974). Red rot pathogen was reported to convert cane sugar into glucose and fructose (Singh, 1964; Agnihotri, 1990). The sucrose content and recovery of sugars were also reported to be reduced in red rot affected canes compared to healthy canes (Kirtikar and Verma, 1962; Sandhu *et al.* 1969). The exact biochemical mechanism that imparts resistance to sugarcane is not fully understood. Reducing sugars were reported to increase in diseased canes (Singh and Waraitch, 1977; Rao *et al.* 1984). Beniwal *et al.* (1989) reported that increase in reducing sugars was minimum in resistant clone Co 7314 and maximum in the highly susceptible clone S 78/560. Although some works have been done on biochemical changes in the sugarcane plant displaying symptoms of red rot, practically no information is available in relation to resistance and susceptible varieties or plants infected by red rot pathogen in Bangladesh. Therefore, an investigation was

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carried out to determine changes in total sugars, reducing and non-reducing sugars in relation to resistance of sugarcane varieties against red rot disease.

MATERIALS AND METHODS

Eight sugarcane varieties of known resistance against red rot pathogen (*Colletotrichum falcatum*) were taken for analyses of post infection biochemical changes on total sugars, reducing and non-reducing sugars. The selected varieties were Isd 2/54, Isd 5/55, Isd 16, Isd 18, Isd 19, Isd 20, Isd 21, and Misrimala. The varieties Isd 19 and Isd 20 were selected as resistant, Isd 2/54 as moderately resistant, Isd 16, Isd 18 and Isd 21 as moderately susceptible and Isd 5/55 and Misrimala were selected as susceptible. Nine months old cane were inoculated on 5th internode (counted from ground level) by specially made inoculating needle (2 cm long & 2 mm dia) at suitable inclination up to pith region and 0.2 ml spore suspension (6'105/ml) of a mixed inoculum was placed inside cavity with the help of hypodermic syringe. The boring point of inoculation was properly sealed by pellet of plasticine and finally wrapped with scotch tape. A separate set of said varieties were also inoculated with sterilized water (control).

Nodal tissue samples without rind were taken from adjacent to inoculated internode by splitting canes after 3, 6 and 12 d after inoculation, cut into small bits, and composite sample from each replication were prepared. The quantitative estimation of total sugars (3 samples/replication) in control and red rot inoculated cane samples were determined by Anthrone method (Dubois *et al.* 1951). Amount in total reducing sugars in control and red rot infected cane samples was estimated by the method described by Miller (1972). The quantitative estimation of non reducing sugars in nodal tissues of control and diseased cane samples were determined by substracting reducing sugars from total sugars obtained by aforesaid methods.

RESULTS AND DISCUSSION

In the present study, total sugars content in fresh nodal tissue samples of eight sugarcane varieties taken from control and diseased canes are presented in the Table 1. Total sugars in inoculated diseased canes after 3, 6 and 12 d of inoculation decreased significantly ($P<0.05$) compared to healthy canes (control). The rate of decrease in total sugars gradually increased after 3, 6 and 12 d of inoculation ranging from 11.1 to 34.79, 15.53 to 40.26 and 22.18 to 37.64% respectively. Similar observation was reported by Singh and Waraitch (1981). They reported that sucrose content decreased gradually from 1.82, 5.92 and 20.99% after 15, 45 and 90 d of inoculation when whole cane was analysed (variety Col. 29). Decrease in sucrose content from 12.2 to 31.2% due to red rot infection by Sandhu *et al.* (1969). In the present investigation decrease in total sugars after 3 d of inoculation was found minimum (11.1%) in the resistant variety Isd 20 while maximum (34.79%) in susceptable variety Isd 5/55. The resistant varieties Isd 19 and Isd 20 showed 25.73 and 18.78% decrease in total sugars, while susceptible varieties Misrimala and Isd 5/55 showed 32.70 and 40.26% decrease respectively after 6 d of inoculation. The resistant varieties Isd 19 and Isd 20 also showed minimum decrease in sugar content compared to susceptible varieties Misrimala and Isd 5/55 after 12 d of inoculation (Table 1). These results are in conformity with the results of Agnihotri *et al.* (1989). They reported that among 8 varieties tested, total carbohydrate decrease was greater in

red rot susceptible varieties like CoLK 8002, CoLK 7810 and Co 997 than in resistant varieties like CoS 767, Co 1158 and CoLK 8001.

Table 1. Changes in total sugars in fresh nodal tissues of different sugarcane varieties due to red rot infection.

Varieties	Total sugars (gm/100 gm fresh tissue weight) [1]								
	3 d after inoculation			6 d after inoculation			12 d after inoculation		
	Control	Diseased	% Decreased	Control	Diseased	% Decreased	Control	Diseased	% Decreased
Isd 2/54	10.67	7.37	30.93	8.96	7.17	19.98	8.80	5.49	37.61
Isd 5/55	8.45	5.51	34.79	7.65	4.57	40.26	6.96	4.34	37.64
Isd 16	10.54	8.84	16.12	9.73	7.16	26.41	8.64	6.18	28.47
Isd 18	10.30	8.75	15.04	8.95	7.56	15.53	7.77	4.89	37.06
Isd 19	11.41	9.09	20.33	9.52	7.07	25.73	8.61	6.70	22.18
Isd 20	9.25	8.22	11.10	8.89	7.22	18.78	8.45	6.55	22.48
Isd 21	9.75	7.85	19.49	8.47	6.85	19.13	8.36	6.30	24.64
Misrimala	9.57	7.60	20.58	9.36	6.30	32.70	7.81	5.81	25.60
Mean	9.99	7.90	20.92	8.94	6.74	24.61	8.18	5.80	
LSD(0.05)	NS	1.226		0.965	0.776		1.062	0.575	
C. V (%)	11.34			6.38			7.04		
S E. Mean	0.207			0.102			0.99		
LSD(0.05)	0.600			0.296			0.288		

[1] Mean of 3 replications

Results on reducing sugars are presented in the Table 2. It is seen from the table that reducing sugars in fresh nodal tissue samples of 8 varieties increased significantly ($P>0.05$) in diseased cane after 3, 6 and 12 d of inoculation compared to control. The increase in reducing sugars content of different varieties ranged from 3.70 to 27.50%, 16.66 to 51.75% and 26.19 to 83.42% after 3, 6 and 12 d of inoculation respectively. In the present investigation, resistant varieties like Isd 19 and Isd 20 always showed low or slow increase in reducing sugars level compared to susceptible varieties like Isd 5/55 and Misrimala after 3, 6 and 12 d of inoculation. The increase in reducing sugars content after 3 d of inoculation was the lowest (3.7%) in resistant variety Isd 20 and the highest (27.50%) in susceptible variety Misrimala. After 6 d of inoculation, resistant variety Isd 20 showed 24.13% increase while susceptible variety Misrimala showed an increase of 51.75%. After 12 d resistant varieties Isd 19 and Isd 20 showed a comparatively lower increase in reducing sugars of 26.19 and 33.43% respectively while susceptible variety Misrimala recorded 83.42% increase. The other moderately resistant and moderately susceptible varieties Isd 16, Isd 18, and Isd 21 showed 44.19, 41.60 and 51.72% increase in reducing sugars respectively (Table 2).

Results confirmed findings of Beniwal *et al.* (1989). They reported that reducing sugars per cent in diseased canes increased in 8 different clones from 7.69 to 44.0% and 10.92 to 89.33% after 4 and 12 d of inoculation respectively. Reducing sugars was more prominent after 12 d of inoculation which ranged between 10.92 and 89.33% in different clones.They observed increase in reducing sugars was minimum (10.92%) in resistant clone Co 7314 and maximum (89.33%) in highly susceptible clone S 78/560. Some other clones showed slow red rot development and recorded moderate increase i.e. 36.00 to 64.81% in reducing sugars. Singh and Waraitch (1977) reported that mean increase in reducing sugars of 7 varieties was 20.03% and decrease in sucrose content was 29.89%

in diseased canes compared to control. In 1981 they reported that sucrose content decreased gradually while reducing sugars increased due to red rot infection after 15, 45 and 90 d of inoculation in the variety CoL 29. The mean increase of reducing sugars was 116.13% due to red rot infection. Rao *et al.* (1984) observed a significant increase in reducing sugars due to red rot.

Table 2.Changes in reducing sugars (gm/100 gm tissues weight) in fresh nodal tissues of different sugarcane varieties due to red rot infection.

Varieties	Total sugar (gm/100 gm fresh tissue weight) [1]								
	3 d after inoculation			6 d after inoculation			12 d after inoculation		
	Control	Diseased	% Decreased	Control	Diseased	% Decreased	Control	Diseased	% Decreased
Isd 2/54	0.21	0.23	9.52	0.24	0.28	16.66	0.26	0.39	50 00
Isd 5/55	0.33	0.42	27.27	0.35	0.47	34.28	0.53	0.81	52.83
Isd 16	0.32	0.35	9.37	0.36	0.43	19.44	0.43	0.62	44.19
Isd 18	0.30	0.37	23.33	0.97	1.31	35.05	1.25	1.77	41.60
Isd 19	0.28	0.30	7.14	0.32	0.40	25.00	0.42	0.53	26.19
Isd 20	0.27	0.28	3.70	0.29	0.36	24.13	0.35	0.46	31.43
Isd 21	0.95	1.05	10.53	1.53	2.27	48.37	2.32	3.52	51.72
Misrimala	0.40	0.51	27.50	1.43	2.17	51.75	1.87	3.43	83.42
Mean	0.382	0.438	14.795	0.686	0.961	31.835	0.928	1.441	47.67
LSD(0.05)	0.073	0.028		0.102	0.049		0.351	0.218	
C. V (%)	0.0064			0.0094			0.0341		
S.E. Mean	7.673			5.574			14.104		
LSD(0.05)	0.019			0.027			0.099		

[1] Mean of 3 replications

In the present investigation, data indicated that there was slight increase in mean reducing sugars of 8 varieties in control cane injected with sterile water after 3, 6 and 12 d of inoculation probably due to wound injury effects. Similar increase in reducing sugars in control canes has also been reported by Beniwal *et al.* (1989).

Data on non reducing sugars are presented in the Table 3. In red rot inoculated diseased cane, mean non reducing sugars in fresh nodal tissue samples of 8 varieties decreased significantly ($P<0.05$) after 3, 6 and 12 d of inoculation compared to healthy canes (control).The present findings are in conformity with the report published elsewhere (Singh and Waraitch, 1977, 1981; Kamal *et al.* 1981; Rao *et al.* 1984). In this investigation, decrease in total non reducing sugars after 3, 6 and 12 d of inoculation ranged from 11.47 to 37.44%, 15.82 to 49.70% and 24.32 to 60.60% respectively. I was revealed that decrease in total non reducing sugars was negetaviely correlated with increase of inoculation period. The decrease in non reducing sugars after 3 d of inoculation in diseased cane was found to be 11.47% in the resistant variety Isd 20 and 37.44% in susceptible variety Isd 5/55. After 6 d of inoculation resistant variety Isd 20 showed 22.13% decrease, while susceptible variety Misrimala showed 49.70% decrease in non reducing sugars. After 12 d of inoculation total non reducing sugars ranged between 24.32 to 60.60%. In the present investigation 24.32% decrease was found in resistant variety Isd 20 and 60.60% decrease was recorded in susceptible variety Misrimala. This result supports the findings of Agnihotri *et al.* (1989). They reported greater decrease in total carbohydrate in red rot susceptible varieties CoLK 8002, CoLK 7810 and Co 997 compared to resistant varieties CoS 767, Co 1158 and CoLK 8001.

It may be concluded that post infection biochemical changes after 3, 6 and 12 d of inoculation with red rot pathogen showed a gradual decrease in total sugars and non reducing sugars but an increase in reducing sugars in nodal tissues of inoculated canes of all varieties tested compared to healthy canes (control). Total sugars

Table 3. Changes in total non reducing sugars (gm/100 gm tissue weight) in fresh nodal tissues of different sugarcane varieties due to red rot infection

Varieties	Total sugar (gm/100 gm fresh tissue weight) [1]								
	3 d after inoculation			6 d after inoculation			12 d after inoculation		
	Control	Diseased	% Decreased	Control	Diseased	% Decreased	Control	Diseased	% Decreased
Isd 2/54	10.46	7.14	31.74	8.72	6.89	15.82	8.54	5.10 B	39.81
Isd 5/55	8.12	5.08	37.44	7.30	4.10	43.83	6.43	3.54 C	44.94
Isd 16	10.22	7.84	23.29	9.37	6.74	28.07	8.24	5.73 A	30.46
Isd 18	10.00	8.39	16.10	8.17	6.27	23.25	6.33	2.97 D	53.08
Isd 19	10.37	8.79	15.24	9.20	6.67	27.50	8.20	6.17 A	24.76
Isd 20	8.98	7.95	11.47	8.81	6.86	22.13	8.10	6.13 A	24.32
Isd 21	8.80	6.83	28.39	6.94	4.46	35.73	6.05	2.78 F	54.05
Misrimala	9.17	7.09	22.68	8.21	4.13	49.70	5.94	2.34 E	60.60
Mean	9.51	7.39	23.29	8.33	5.77	30.75	7.23	4.28	41.50
LSD(0.05)	NS	1.106		0.84	0.816		1.103	0.551	
C. V (%)	11.385			6.586			8.659		
S.E. Mean	0.196			0.095			0.102		
LSD(0.05)	0.569			0.275			0.294		

[1] Mean of 3 replications

and non reducing sugars in inoculated (diseased) canes after 3, 6 and 12 d of inoculation decreased significantly, while reducing sugars increased compared to control. In all 8 varieties, decrease in total sugars and nonreducing sugars were always higher in diseased canes with increase of inoculation period. However, resistant varieties like Isd 19 and Isd 20 always showed the lowest decrease in total sugars and non reducing sugars compared to susceptible varieties Isd 5/55 and Misrimala while the lowest increase in reducing sugars was found in resistant varieties compared to susceptible varieties.

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