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Role of Sugar Compounds in Plant Defense to Alternaria Blight

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Abstract

The non-reducing sugars varied from 1.10% to 1.70%. The lowest and the highest non-reducing sugar contents were recorded in genotypes PSR-22 and PCR-9305 respectively in healthy leaves whereas in case of diseased leaves the non-reducing sugar contents varied from 0.79% (PCR-9305) to 1.95% (Varuna). The magnitude of reduction in this case was 22% due to occurrence of disease. Once the pathogen establishes its introduction in the host tissues, it starts feeding the nutrients from host and simple sugars are by far the first nutrient to be taken up by the fungi. Several workers have studies the alterations in the reducing and the non-reducing sugar contents due to pathogenic attack. The reducing sugar content varied from 3.52% to 4.50% in case of healthy tissues. This range was recorded from 3.0% to 3.70% in case of tissues infected by *A. brassicae*. Non-reducing sugars recorded a range of variation from 1.15% to 1.65% in healthy tissues and 0.88% to 1.10% in diseased tissues. The non-reducing sugars ranged from 1.10% to 1.70% and 0.79% and 1.95% in healthy and diseased tissues respectively. In the opinion of author the disease causes a derangement in the host plant metabolism and the simple sugars are the first preference for the nutrition of parasite. This might be cause of decline in the simple sugar. With the growth and proliferation of pathogen further breakdown of sugars might convert non-reducing sugars into reducing sugars, which might easily be utilized by pathogen.

Keywords: Non-reducing sugars; Reducing sugars; *A. brassicae*.

Introduction

Extensive literature is available on the role of sugars in resistance of plant to various diseases. Higher plants contain considerable amount of sugars and related compounds. Carbohydrates are major constituents of nutrition because of the fact that almost entire energy for cellular activity is derived from their breakdown. Carbohydrates required for energy production and for participation in metabolic reactions are generally present as monosaccharides e.g. glucose, fructose etc. Attempts have been made by several workers to correlate disease reaction in plants with sugar content. Firstly, a disease is categorized on the basis of sugar content of host tissues. These diseases are of two types e.g. a “high sugar” disease and a “low sugar” disease. Powdery mildew and the rust fall under the category of high sugar diseases wherein the plant contains higher level of sugars (Horsfall and Diamond, 1957). In case of stem rust of wheat, the total sugars specially sucrose fractions decreased with the progress of infection. The decrease in sugar content was found to be closely related with severity of rust infection (Krog et al. 1961). Grewal and Grower (1974) observed that total sugars were reduced during pathogenesis in case of red fruit of chilies infected with *Colletotricum piperatum*. However, (Chopra and Jhooty, 1974) observed no significant changes in case of glucose content of watermelons after infection due to *Alternaria cucumarina.*

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In case of pearl millet, the rate of carbohydrate synthesis was lower in leaves infected by downy mildew than that in healthy ones. Reducing sugars were more and non-reducing sugars were less in infected leaves than those in control leaves (Garg and Mandahar, 1975).

In case of safflower leaves infected with rust, it was observed that total sugar decreased (Prasad et al., 1976). Total soluble sugar contents were also reported to increase in the leaves of date palm infected by smut (Kapoor et al., 1978).

The pathogen utilized considerable amount of sucrose, glucose and fructose during pathogenesis in apple fruit infected by *Clathridium corticola* (Thind et al., 1977). In cotton, seedling role of sugar in resistance was observed that gradual reduction in sugar content was noticed with increase in the age (Ramaswami and Shanmugam, 1977).

The increase in water soluble sugars infected leaves of groundnut resulted by rust (Puccinia arachidis) (Siddaramaiah et al., 1979). The leaves of phyllody affected sesame plants contained lower sugars (total and reducing) (Prasad and Sahambi, 1980). In cauliflower total sugars and reducing sugars observed in healthy tissue showed a considerable decrease after infection by *Sclerotinia sclerotiorum* while non-reducing sugars were accumulated after infection as time interval elapsed (Sharma and Sharma, 1980).

In pearl millet, the amount of reducing sugar increased in susceptible lines after inoculation with downy mildew, while reverse trend was noted for starch accumulation. Reducing sugars and starch contents remain unaltered in resistant line during early stages of plant growth, upon infection (Mogle and Mayee, 1981).

There were both quantitative and qualitative changes in sugar content in the response to infection by *Geotrichum candidum* in round gourd. This decrease in sugars in infected round gourd is likely to be related to the breakdown of carbohydrate by fungal enzyme or host carbohydrate being used as substrate or increased respiration rate. The fruit of local variety of mandrin infected with *Alternaria citri* showed a decrease in total soluble solids, ascorbic acid and percentage acidity. The amount of three sugars viz. sucrose, fructose and glucose found in healthy fruits was reduced in the diseased ones (Agarwal and Khare, 1983).

Recently total sugar, reducing sugar measured in inter nodes of 3 tolerant and 3 susceptible sorghum genotypes naturally infected with *Macrophomina phaseolina* in India in 1978. In tolerant genotype, sugar levels were 2-3 times higher than those in susceptible ones. High levels of sugars are considered to attribute to resistance mechanism (Patil et al., 1985). It is also noted recently that the level of sugars in diseased fruits, varied with disease development. Reducing, non-reducing and total sugars decreased considerably in the infected tissues throughout the incubation period. Fruits affected with Helminthosporium spiciferum showed a remarkable fall in the percentage of total sugar content (Roy and Choudhary, 1985).

The quantity of sugars in root and first inter node was more in resistant genotype than those in susceptible genotype of sorghum at physiological maturity. Further the quantity of sugars decreased considerably in susceptible genotype infected with charcoal rot from full flowering stage thus succumbing to infection leading to lodging up to 100% whereas in resistant genotype, the quantity of sugars was more than in susceptible genotype from flowering stage onwards thus succumbing least to infection leading to least lodging (Anohusur and Naik, 1985).

Reducing sugars and starch content also reduced in leaves of medicinal plant *Boerhaavia diffusa* infected by white rust (Kumar and Manoharachari, 1985).

Materials and Methods

Reducing non-reducing and total sugars were estimated by Ferricyanide method as given by AOAC (1970).

Results and Observations

To study the metabolic alterations in the reducing, non-reducing and total sugars with the establishment of pathogenicity of the two causal organisms of Alternaria blight in *Brassica juncea* their concentrations were analyzed in the same set of experiments. The data are expressed here as the percentage of moisture free leaf tissues in Tables 1.

Reducing sugars comprised as the major components (about 75% of total sugars) and the rest was accounted for non-reducing sugars. The genotypes exhibited considerable variability in reducing, non-reducing and total sugar contents both in case of healthy and diseased tissues infected by *A brassicae*. In case of *A brassicae* infection, the variation in reducing sugar contents was recorded from 3.47% in genotype DIM-52 to 4.5% in variety Varuna under disease free condition. However

Table 1: Comparative Evaluation of Mustard varieties for Sugar content in Relation to Healthy and Diseased Leaf Tissues (% of leaf dry matter) Causal organism- Alternaria brassicae

Sl. No.	Varieties	Healthy			Diseased		
		Reducing	Non-reducing	Total	Reducing	Non-reducing	Total
1	DIR-621	4.28	1.32	5.60	3.7	0.97	4.69
2	JGM-9508	4.14	1.35	5.45	3.42	0.39	4.31
3	PCR-9306	3.39	1.25	5.20	3.40	0.88	4.28
4	PROAGRO-1101	3.66	1.15	4.81	3.35	1.02	4.37
5	RK-9504	4.01	1.65	5.66	3.70	1.10	4.80
6	DIM-52	3.47	1.49	4.96	3.00	0.95	3.95
7	TKG-5	3.89	1.22	5.06	3.50	0.89	4.39
8	RK-9501	3.52	1.24	4.76	3.02	0.88	3.90
9	JGM-95	4.05	1.33	5.38	3.45	0.94	4.39
10	PSR-22	4.12	1.27	5.39	3.15	0.91	4.06
11	VSL-5	4.14	1.29	5.43	3.46	0.87	4.33
12	Varuna	4.50	1.70	6.20	3.44	0.88	4.32
	Mean	3.93	1.36	5.33	3.38	0.89	4.31

under disease infection condition reducing sugars ranged from 3% (DIM-52) to 3.7% (DIR-621). The reducing sugar contents also registered a regular decrease due to *A. brassicae* infection.

The magnitude of reduction (as indicated) by the mean value due to disease occurrence was 15% in case of reducing sugars. There was comparatively greater reduction in case of non- reducing sugar due to occurrence of disease as there was about 32% reduction indicating that the pathogen has a preferential feeding tendency for non- reducing sugars.

The magnitude of reduction in reducing sugar contents due to occurrence of disease was 12.7%. The highest reducing sugar contents in healthy tissue was recorded in RK-9504 in this case also whereas genotype VSL-5 with its 3.42% reducing sugar contents gave the lowest value in disease free leaves. The corresponding range of variation in case of diseased leaves was recorded from 3.10% to 3.75%. The latter value was recorded in genotype RK-9504 again.

The non-reducing sugars varied from 1.10% to 1.70%. The lowest and the highest non-reducing sugar contents were recorded in genotypes PSR-22 and PCR-9305 respectively in healthy leaves whereas in case of diseased leaves the non-reducing sugar contents varied from 0.79% (PCR-9305) to 1.95% (Varuna). The magnitude of reduction in this case was 22% due to occurr Awasthi (1987) reported that the reducing sugars decreased while the non-reducing sugars remained unaltered in the leaves of *Brassica juncea* attacked by Alternaria blight. In case of infection by white rust and downy mildew the non-reducing sugar contents tended to increase at the advanced stage of infection. Tewari (1993) studied the biochemical composition of susceptible and tolerant varieties of mustard and found that non-reducing sugars were higher in tolerant types. Similar results have been obtained by other workers (Horsfall and Diamond, 1957; Siddaramaiah, 1979).

In the present investigation, the results obtained are in conformity with above workers. The results in the present study showed a marked deviation from those reported by Tewari (1993) as in this case both reducing and non-reducing sugars were decreased due to disease. This might be cause of decline in the simple sugar. With the growth and proliferation of pathogen further breakdown of sugars might convert non-reducing sugars into reducing sugars, which might easily be utilized by pathogen. A more or less similar conclusion has been reported to be drawn by Awasthi (1987).

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