STUDIES ON PIGEON PEA STERILITY MOSAIC DISEASE

VI. Effect of Disease on Carbohydrate

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Abstract

Total carbohydrates were significantly less in virus diseased pigeon pea leaves at all ages below the second leaf than in comparable healthy leaves. While the total carbohydrate content increased with age in healthy plants, no such regular pattern was discernible in diseased leaves. Starch and resin were significantly lower in diseased leaves than in healthy leaves and sucrose levels were not significantly different. Increased levels of reducing sugars and non-fermentable reducing substances were observed in diseased leaves over healthy leaves.

Introduction

Narayanasamy and Ramakrishnan (1965) studied the effect of pigeon pea sterility mosaic disease on carbohydrate content of pigeon pea [*Cajanus cajan* (L.) Millsp.] leaves. In the present paper results of further studies on different fractions of carbohydrates content of pigeon pea leaves as affected by age of leaf and duration of infection are presented.

Materials and Methods

Pigeon pea plants (SA 1 variety) infected under field conditions by pigeon pea sterility mosaic virus (PSMV) were used for the present study. Leaves at consecutive ages from leaf-bud to the sixth leaf below were analysed for the different fractions of carbohydrates. The petiole, stem and root were also analysed for the carbohydrates content.

Total carbohydrates were estimated in sap clarified by the method of Doak (1939). The different fractions of carbohydrates such as reducing

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sugar, invert sugar, non-fermentable reducing substances and starch were estimated by the copper reduction method of Van der Plank (1936). The method of Shewan (1938) was adopted to estimate the resin content.

TABLE I

Total carbohydrate in leaves, petiole, stem and root of healthy and PSMV-affected pigeon pea plants (Percentage dry weight)

Plant Part	Healthy	Diseased	% increase (+) or decrease (−) over healthy
Leaf-bud ..	6·92	6·59	— 4·79
Leaf No. 1 ..	7·50	6·97	— 7·06
„ 2 ..	7·80	6·84	—12·30
„ 3 ..	9·00	6·55	—27·33
„ 4 ..	9·43	6·94	—26·44
„ 5 ..	10·82	7·75	—28·37
„ 6 ..	9·68	6·57	—34·03
Petiole ..	6·05	4·96	—18·15
Stem ..	5·25	3·61	—38·39
Root ..	7·54	6·52	—17·36

RESULTS

Total carbohydrate.—The data are presented in Table I. There was a steady increase in total carbohydrate content in healthy leaves up to the fifth leaf and thereafter it declined. However, no such regular increase was observed in diseased plants. In diseased plant the total carbohydrate content was significantly less in leaves at all ages below the second leaf than in healthy counterparts. The diseased petiole, stem and root tissues had 18·15, 38·39, and 17·36 per cent. less total carbohydrate than in comparable healthy counterparts.

TABLE II

Carbohydrate constituents in leaves, petiole, stem and root of healthy and PSMV-affected pigeon pea plants (expressed as percentages on residual dry weight except in the case of resin which is expressed as percentage on dry weight

Plant part	Reducing sugars			Invert sugars			Sucrose		
	Healthy	Diseased	% increase (+) or decrease (−) over healthy	Healthy	Diseased	% increase (+) or decrease (−) over healthy	Healthy	Diseased	% increase (+) or decrease (−) over healthy
Leaf-bud	0·80	0·79	− 1·25	1·11	1·15	+ 3·60	0·29	0·33	+13·79
Leaf No. 1	0·89	0·90	+ 1·12	1·30	1·37	+ 5·38	0·39	0·45	+15·38
,, 2	1·01	1·08	+ 6·93	1·69	1·73	+ 2·37	0·64	0·62	− 3·13
,, 3	1·13	1·24	+ 9·73	1·63	1·60	− 1·84	0·48	0·34	−29·16
,, 4	1·10	1·15	+ 4·55	1·65	1·70	+ 3·03	0·52	0·47	− 9·61
,, 5	1·04	1·13	+ 8·65	1·54	1·58	+ 2·60	0·47	0·42	−10·64
,, 6	1·11	1·16	+ 4·51	1·55	1·60	+ 3·22	0·44	0·41	− 6·82
Petiole ..	0·57	0·58	+ 1·75	0·82	0·89	+ 8·54	0·24	0·22	− 8·33
Stem ..	0·63	0·71	+12·70	0·87	0·90	+ 3·45	0·21	0·18	−14·29
Root ..	0·51	0·57	+11·75	0·72	0·86	+19·44	0·19	0·18	− 5·26

Plant part	Non-fermentable reducing substances			Starch			Resin		
	Healthy	Diseased	% increase (+) or decrease (−) over healthy	Healthy	Diseased	% increase (+) or decrease (−) over healthy	Healthy	Diseased	% increase (+) or decrease (−) over healthy
Leaf-bud	0·40	0·43	+ 7·50	5·42	5·17	− 4·61	27·3	24·3	−10·98
Leaf No. 1	0·47	0·47	Nil	6·57	5·48	−16·56	28·7	26·7	− 4·98
,, 2	0·46	0·49	+ 6·52	6·76	4·25	−37·14	32·0	28·4	−11·25
,, 3	0·43	0·52	+20·93	6·33	4·38	−30·80	35·6	32·3	− 9·27
,, 4	0·55	0·67	+21·82	6·19	4·32	−30·21	39·3	35·0	−10·94
,, 5	0·62	0·75	+20·97	6·46	4·24	−34·38	30·2	26·5	−12·26
,, 6	0·56	0·75	+33·93	6·15	4·30	−30·08	28·9	26·2	− 9·34
Petiole ..	0·31	0·40	+29·03	3·00	2·63	−12·33	28·6	20·4	−28·67
Stem ..	0·30	0·37	+23·33	3·64	3·18	−12·64	26·7	24·3	− 8·99
Root ..	0·33	0·40	+21·21	3·65	3·11	−14·79	19·9	19·5	− 2·01

Reducing sugars.—The diseased leaves at all ages had a higher co of reducing sugars than healthy leaves of corresponding ages. In healthy and diseased leaves there was an increase in reducing sugar co with increase in age of leaf up to the third node, and thereafter redı sugar levels were more or less stationary. The stem and roots of dis plants had conspicuously less reducing sugar content than those of he plants (Table II).

Invert sugar.—The increase in invert sugar in diseased leave over he ones was not significant. However, the age of the leaf did exert a signi influence on the level of invert sugar (Table II).

Sucrose.—Disease did not significantly alter the level of sucrose. seemed to influence the level of sucrose in both healthy and diseased l (Table II).

Non-fermentable reducing substances.—The levels of non-fermer reducing substances in diseased leaves were generally more than in he leaves and this higher level was maintained at all ages of leaves exce first leaves on diseased plant. The older leaves had higher levels of substances than the younger ones both in healthy and diseased l (Table II).

Starch.—Diseased leaves at all ages had significantly less starch their healthy counterparts. There was a steady decrease in starch cc with age of leaves (Table II).

Resin.—Resin content was lower in diseased leaves at all ages over healthy counterparts. The pattern of change with age in the levels of in both healthy and diseased levels was more or less the same. Ther a conspicuous decrease in resin content in diseased petiole, stem and over comparable healthy tissues.

DISCUSSION

It is the consensus that in mosaic type virus diseases profound ch in carbohydrate metabolism take place. The present investigation re the sequence of change in different fractions of carbohydrates as af by age and disease. A significant decrease in total carbohydrate in dis leaves (2nd leaf downwards) over comparable healthy ones was obs (Table I). This is to be expected as a consequence of retarded photosyn observed in PSMV-affected pigeon pea leaves (Nambiar, 1966). A re capacity to synthesize carbohydrate is characteristic of mosaic-al

plants (*see* Diener, 1963). Narayanasamy and Ramakrishnan (1965) found an altered ability to synthesize carbohydrates in PSMV-infected pigeon pea leaves and concluded that the translocation of photosynthates from leaf to the other parts was affected by virus infection. The present finding of a reduced level of sucrose and starch with a concomitant increase in the level of reducing sugars is in conformity with the observations of Narayanasamy and Ramakrishnan (1965) and Jeyarajan (1965). Eskarons and Naguib (1964) could not find any difference in the level of total carbohydrate or carbohydrate fractions between healthy and tobacco mosaic virus (TMV)-infected plants. The rapid depletion of carbohydrate resulting from enhanced respiration would also lead to reduced levels of carbohydrates. An increase in reducing sugars has been observed in sugar beet leaves affected by beet mosaic virus (Watson and Watson, 1951).

One of the metabolic functions of the sugars is the formation of phosphate esters which serve as substrates for respiration, and the release of energy. Due to retarded photosynthetic activity, less of starch may be synthesized in diseased leaves. An enhanced rate of respiration observed in pigeon pea leaves (Nambiar, 1966) may cause a rapid transformation of starch into sugars which are the respirable substrates, and their rapid utilisation resulting in decreased levels of starch and sucrose.

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