Phyton (Austria)	**Vol. 26**	Fasc. 2	165–170	15. 4. 1987

Chemical Composition of Cowpea Seeds as influenced by Southern Bean Mosaic Virus and Cowpea Mosaic Virus

By

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Received November 4, 1985

Key words: Chemical composition, Southern bean mosaic virus, Cowpea mosaic virus, cowpea, *Vigna sinensis*.

Summary

SINGH A. K. & SINGH A. K. 1987. Chemical composition of cowpea seeds as influences by southern bean mosaic virus and cowpea mosaic virus. – Phyton (Austria) 26 (2): 165–170. – English with German summary.

In the present study changes in chemical composition of seeds of cowpea (*Vigna sinensis* [L.] SAVI ex HASSK.) cv. Pusa Dufasli due to southern bean mosaic virus and cowpea mosaic virus have been investigated. Both the viruses reduced the carbohydrate fractions (total, reducing, non-reducing sugars and starch) in comparison to healthy ones. Total phosphorus, organic phosphorus, total nitrogen, protein and total free amino acids increased in the fruit parts due to SBMV infection while inorganic phosphorus, nitrate, nitrate nitrogen and ammoniacal nitrogen was reduced. CpMV infection increased the total nitrogen and protein in the fruit coat but reduced in other fruit parts. All the phosphorus fractions were also reduced in diseased fruit parts in comparison to their healthy counter parts.

Zusammenfassung

SINGH A. K. & SINGH A. K. 1987. Chemische Zusammensetzung der Samen der Kuhbohne unter der Einwirkung des southern bean mosaic virus und des cowpea mosaic virus. – Phyton (Austria) 26 (2): 165–170. – Englisch mit deutscher Zusammenfassung.

Die Änderungen der chemischen Zusammensetzung von Samen der Kuhbohne (*Vigna sinensis* [L.] SAVI ex HASSK.) cv. Pusa Dufasli nach Infektion mit southern bean mosaic virus (SBMV) und cowpea mosaic virus (CpMV) werden untersucht. Beide Viren setzen den Kohlenhydratanteil (Gesamt-, reduzierende und nichtreduzierende Zucker sowie Stärke) herab. Der Gehalt an Gesamt- und organischem Phosphor, an

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Gesamtstickstoff, Protein und an freien Aminosäuren wird durch Infektion mit SBMV in allen Fruchtteilen erhöht, während der organische Phosphor, Nitrat-, Nitrit- und Ammoniakstickstoff abnehmen. CpMV erhöht den Gesamtstickstoff- und den Proteingehalt in den Fruchtwänden, erniedrigt ihn jedoch in den übrigen Teilen der Frucht. Auch die Phosphatfraktionen sind in den Fruchtwänden virusbefallener Pflanzen unter die Werte gesunder Vegleichspflanzen erniedrigt.

Introduction

The dried seeds of cowpea are an important pulse in the tropics and subtropics and entered into the daily food of a considerable number of people. Fresh seeds and mature pods are eaten raw and they may be frozen or canned. The seeds are sometimes used as a coffee substitute and the young shoots and leaves are eaten as spinach. The crop also yields excellent forage both for cutting and stall feeding and for making into hay or silage. In some countries a strong fiber is extracted from the peduncles of a variety of cowpea.

Recently, SINGH (1982) has recorded that the crop of cowpea suffers heavily due to southern bean mosaic virus (SBMV) and cowpea mosaic virus (CpMV) in eastern U.P. (India). Pods produced by diseased plants were usually fewer and smaller in size. Physiological disturbances which accompany virus infection has been reported mainly in the vegetative parts of the host. Such studies in the composition of leguminous seeds infected with viruses are limited (SINGH & MALL 1974, SUTERI & BHARGAVA 1975, SINGH & MALL 1978). Considering the economic importance of cowpea the present study was undertaken to investigate the effect of cowpea mosaic virus and southern bean mosaic virus infection on chemical composition of cowpea seeds.

Materials and Methods

The experiment was performend in an insect-proof glasshouse. Cowpea (*Vigna sinensis* [L.] SAVI ex HASSK.) cv. Pusa Dofasli was used as host and cowpea mosaic virus (CpMV) and southern bean mosaic virus (SBMV) as viruses. The culture of the viruses was maintained in the laboratory (SINGH 1982). The plants were raised in 30 cm clay pots having unsterilized sand, loam and compost mixture (1 : 1 : 2) with two seedlings per pot.

Three groups of seven days old seedlings of cowpea were taken. Each group contained 120 seedlings. First and second group of seedlings were inoculated separately with CpMV and SBMV by usual leaf rubbing method using carborundum (600 mesh) as an abrasive and the seedlings of third group with carborundum mixed distilled water to serve as healthy control. Mature pods of healthy and diseased plants were separately collected after 120 days of inoculation. Just after harvesting cowpea pods (fruits) were subjected for drying in an electric oven maintained at $80° \pm 5°$ C for 24^h.

After drying the pods were separated into fruit coat, seed coat and cotyledons. Respective samples were powdered finely and mixed properly. Estimations of chemical constituents were made from dried samples. For each analysis average of the three valus were taken and presented in the results.

The total nitrogen (DONEEN 1932), nitrate, nitrite nitrogen (HUMPHRIES 1956), total free amino acids (WIGGINS & WILLIAMS 1955), ammonical nitrogen (STROGANOV 1964), total phosphorus (HUMPHRIES 1956), inorganic phosphorus, total, reducing sugars and starch (SNELL & SNELL 1954) were estimated as described. Non-reducing sugars were converted to reducing one by the method of SOMOGYI (1952). For total protein, the samples were ground with 10% TCA, centrifuged and the residue was placed in an oven at 70° C for drying. The nitrogen content was estimated as above and was multiplied by 6.25 to get the value for protein. The amount of organic phosphorus was calculated from the total phosphorus after reducing the amount of inorganic phosphorus.

Results and Discussion

Carbohydrate fractions (total, reducing, non-reducing sugars and starch) were reduced due to virus infection. The SBMV caused greater reductions in carbohydrate contents of fruit parts (Table 1). Virus induced disturbances in carbohydrate synthesis in leaves may directly influence its distribution in other plant parts including fruits. Mosaic type viruses are known to reduce the carbohydrate content in infected plants (BAWDEN 1963, DIENER 1963). Under the condition of virus infection the leaves show decreased rate of photosynthesis but have enhanced rate of respiration (GOODMAN & al. 1967). Carbohydrates formed in the leaves are translocated to the seeds for storage. The decrease in sugars and starch in seeds is because of their lesser translocation to the seeds.

Total and organic phosphorus was increased due to SBMV infection while inorganic phosphorus was decreased. The basic need of virus multiplication is the synthesis of virus specific nucleic acid. SBMV being a systematic and seed borne virus (SINGH 1982), its virus specific nucleic acid would have accumulated in fruits, while as a results showed increased total and organic phosphorus content. The CpMV infection reduced the content of total, organic and inorganic phosphorus. Some workers (REDDI 1966, REDDI & ANJANEYALU 1963) are of the opinion that the nucleosides from ribosomal RNA are used for viral RNA synthesis. This suggests that seeds of virus infected plant receive low amount of total and organic phosphorus for storage than the seeds of healthy plants. Further CpMV is not a seed-borne virus (SINGH 1982). This also may be a possible reason for low level of organic and total phosphorus in seeds of CpMV infected plant. The low level of inorganic phosphorus in diseased fruits probably reveals its quick con-

Table 1

Carbohydrate, nitrogen and phosphorus contents (mg/100 mg dry wt., except nitrite nitrogen) of parts of cowpea fruits infected with cowpea mosaic virus (CpMV) and southern bean mosaic virus (SBMV)

Fraction	Fruit part	Healthy	CpMV	SBMV
Total sugar	Fruit coat	1.90	1.70	1.55
	Seed coat	2.30	1.95	1.80
	Cotyledon	3.60	3.10	2.90
Reducing sugar	Fruit coat	1.15	1.00	0.90
	Seed coat	1.35	1.20	1.10
	Cotyledon	2.40	2.10	2.00
Non-reducing sugar	Fruit coat	0.75	0,70	0.65
	Seed coat	0.95	0.75	0.70
	Cotyledon	1.20	1.00	0.90
Starch	Fruit coat	18.20	15.10	14.70
	Seed coat	12.55	10.90	10.00
	Cotyledon	20.66	17.40	16.30
Total nitrogen	Fruit coat	1.75	2.20	2.45
	Seed coat	1.90	1.75	2.15
	Cotyledon	3.20	2.95	3.70
Protein	Fruit coat	4.80	5.60	6.10
	Seed coat	7.10	6.20	8.00
	Cotyledon	21.30	18.50	22.50
Nitrate nitrogen	Fruit coat	0.110	0.102	0.100
	Seed coat	0.145	0.120	0.108
	Cotyledon	0.200	0.180	0.165
Nitrite nitrogen	Fruit coat	4.80	4.10	3.85
(μg/100 mg dry wt.)	Seed coat	4.10	3.75	3.40
	Cotyledon	3.50	3.25	3.10
Ammoniacal nitrogen	Fruit coat	0.021	0.015	0.010
	Seed coat	0.030	0.024	0.020
	Cotyledon	0.055	0.040	0.035
Total free amino	Fruit coat	0.70	0.75	0.80
acids	Seed coat	0.50	0.56	0.60
	Cotyledon	1.30	1.70	1.85
Total phosphorus	Fruit coat	0.165	0.150	0.190
	Seed coat	0.130	0.110	0.145
	Cotyledon	0.350	0.300	0.380
Inorganic phosphorus	Fruit coat	0.040	0.030	0.030
	Seed coat	0.020	0.010	0.025
	Cotyledon	0.070	0.050	0.050
Organic phosphorus	Fruit coat	0.125	0.120	0.160
	Seed coat	0.110	0.100	0.130
	Cotyledon	0.280	0.250	0.300

version into organic form for their incorporation into virus specific nucleic acid.

Results of Table 1 indicate that total nitrogen and protein was higher in fruit coat but lower in other fruit parts due to CpMV infection. However, the percentages of nitrate, nitrite nitrogen and ammoniacal nitrogen was lower in deseased fruit parts than the healthy ones. The low levels of nitrogenous fractions seems to be due to low avialability of these fractions in storable forms to the seeds. The increased contents of total nitrogen, protein and total free amino acids in SBMV infected fruits may be due to higher availability of storable plant protein to the fruits. Increased levels of these nitrogenous fractions in infected samples, appear as a result of virus multiplication involving synthesis of virus specific protein. TAKAHASHI & ISHII (1952) indicated that the infected plants contained, in addition to virus, varying amount of abnormal protein.

Acknowledgement

The authors are thankful to Dr. P. P. SINGH, Principal, M. L. K. College, Balrampur, Gonda and Dr. R. B. SINGH, Department of Plant Pathology, Institute of Agricultural and Animal Sciences, Pakhlihawa campus, Bhairahawa, Nepal, for facilities and valuable suggestion, respectively.

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