the press mud contains some sugars which were utilized immediately by the bacteria to produce the desired substrates (*e.g.*, acetic acid, H_2 and CO_2) for methanogenesis. The other reason could probably be the availability of some trace elements and growth substances from press mud for microbial community. Besides this, addition of some desired bacterial community (*e.g.*, propionate catabolizing) due to addition of press mud cannot be ruled out. The last reason is substantiated on the basis of the results presented in Table II. Significant level of propionate, iso-butyrate, butyrate and valerate was built up in CW fermentor while in the case of CW+PM fermentor the build up of these acids was not significant. Utilization of propionate has been reported to be slow and does not allow methanogenesis to proceed faster[6].

As can be seen from the data presented in Table III, comparatively, there was more destruction of volatile substances in CW+PM mixture than in CW alone. Although there was not much difference in cellulose degradation between the two wastes (Table III), yet there was about 33% more gas production from CW+PM mixture than from CW alone (Table I). Higher cellulose degradation would not necessarily result in increased gas production unless the products of hydrolysis are fermented only to acetate, CO_2 and H_2. This is, however, dependent upon the partial pressure of H_2 in the system[3,4,7]. The methane content varied between 62–66% in both the fermentors, the remaining 34–38% being the CO_2. There was no degradation of lignin. The increase in lignin per cent, however, was due to the reduction in total solids.

These results suggest that gas production can be increased by supplementing cattle waste with press mud @ 10% to start with as this would help in an early establishment of the system.

November 20, 1980.

1. Bryant, M. P., In: *Proc. Seminar on Microbial Energy Conversion* (H. G. Schlegel and J. Barnia, eds.), E. Coltze, K. G., Gottingen, *1976*.
2. Carlsson, J., *Appl. Microbiol.*, 1973, 25, 287.
3. Chen, M. and Wolin, M. J., *Appl. Environ. Microbiol.*, 1977, 34, 756.
4. Ianotti, E. L., Kafkewits, D., Wolin, M. J. and Bryant, M. P., *J. Bacteriol.*, 1973, 114, 1231.
5. Jain, M. K., Singh, R. and Tauro, P., *Agricultural Wastes*, 1981, 3, 65.
6. Jeffries, T. W., Onstead, D. R., Cardenas, R. R. and Gregor, H. P., *Biotech. and Bioengg.*, 1978, Symp. No. 8, 37.
7. Latham, M. J. and Wolin, M. J., *Appl. Environ. Microbiol.*, 1977, 34, 297.
8. Zeikus, J. G., *Bacteriol. Rev.*, 1977, 41, 514.

ROLE OF SOLUBLE SUGARS IN THE RESISTANCE OR SUSCEPTIBILITY OF GREENGRAM VARIETIES TO BACTERIAL LEAF BLIGHT CAUSED BY *XANTHOMONAS PHASEOLI*

T. MARIMUTHU
National Pulses Research Centre
TS. 1484, West III Street
Pudukkottai 622 001, India
AND
T. K. KANDASWAMY
Professor and Head
Agricultural College and Research Institute
Madurai 625 104, India

GREENGRAM (*Vigna radiata* var. *aureus*) varieties differ in their reaction to *X. phaseoli* inoculation[1]. The present study was aimed at understanding the role of soluble sugars in imparting tissue resistance/susceptibility to the selected cv. of greengram, *viz.*, Co 2, Co 3 and Co 1 which are moderately resistant, susceptible and highly susceptible to *X. phaseoli*, the incitant of bacterial leaf blight, respectively. Extensive studies have been made on the role of sugars in host parasite interaction of fungal pathogens[2,3]. The information on the bacterial pathogens are scanty[4] and no information is available on the role of soluble sugars in the greengram—*X. phaseoli* interaction.

Seeds of all the three cultivars, *viz.*, Co 2, Co 3 and Co 1 were sown in mud pots (30 cm dia) containing standard pot mixture. Five plants were maintained in each pot. Thirty-five days old plants were spray inoculated with the cell suspension of the pathogen (ca. 10^8 cells/ml of dist water) as per the method of Kiraly[5]. Leaf samples were collected from all the varieties at 0, 12 hr, 1, 3, 5 and 10 days after inoculation.

Five g of fresh leaf tissues were extracted in boiling 80% ethanol[6] for the estimation of sugars.

The non-reducing sugars of the alcohol extract was converted into reducing sugars[7] and then the total sugars estimated[8].

The qualitative nature of sugars in the extract was determined by unidimensional ascending chromatography following the methods of Barton[9]. The solvent system consisted of *n* butanol : acetic acid : water : 4 : 1 : 1 (v/v). Aniline hydrogen phthalate served as detection reagent. Co-chromatography with the authentic samples of sugars helped in the identification of unknowns in the extract. Spot areas from the corresponding unsprayed chromatogram were cut and eluted with deionized water and quantified using anthrone reagent[10].

The data on the sugar content reveal that the variety Co 2 contained the least amount of total soluble

TABLE I

Changes in total soluble sugar content of the three greengram varieties due to* X. phaseoli *inoculation.*

Sampling interval (days)	Co 2		Co 3		Co 1	
	Healthy	Inoculated	Healthy	Inoculated	Healthy	Inoculated
0	12·75	12·78	16·74	15·85	15·45	14·98
12 h	11·90	13·23	16·32	14·63	14·90	14·23
1	12·32	11·15	15·65	13·33	14·02	12·28
3	12·12	9·99	14·66	11 08	12·78	10·99
5	13·27	10·23	12·77	11·91	13·01	13·55
10	12·98	11·79	13·92	12·32	13·53	14·09

* mg/g of dry tissue in glucose equivalent

	CD (P=0·05)
Variety	0·06
Inoculation	0·05
Interaction	0·19

TABLE II

Changes in glucose content of the three greengram varieties due to* X. phaseoli *inoculation.*

Sampling interval (days)	Co 2		Co 3		Co 1	
	Healthy	Inoculated	Healthy	Inoculated	Healthy	Inoculated
0	1·70	1·46	2·94	2·81	3·41	3·30
12 h	1·90	1·50	2·50	2·01	3·20	3·15
1	2·10	0·90	2·30	1·95	3·30	3·10
3	2·03	0·69	2·00	1·91	3·50	3·27
5	2·20	0·80	2·26	1·18	3·01	2·98
10	2·50	1·80	1·70	1·02	2·00	1·23

* mg/g of dry tissue

	CD (P=0·05)
Variety	0·13
Inoculation	0·11
Interaction	0·45

sugars (Table I), glucose and fructose than the susceptible ones which contained higher reserve of the same (Tables II and III). Pathogenic inoculation resulted in a decrease in the levels of total soluble sugars and glucose in all the three varieties. However, the reduction was strikingly more so with moderately resistant Co 2 than in others. It is quite possible that in the moderately resistant Co 2, a greater breakdown of sugars was warranted to meet the energy requirements for the enhanced synthesis of defense compounds like phenolics[11,12]. The intermediary compounds formed during the breakdown of carbohydrates *via* the pentose phosphate respiratory cycle serve as the precursors for the synthesis of phenolic compounds.

TABLE III

Changes in fructose content of the three greengram varieties due to* X. phaseoli *inoculation*

Sampling interval (days)	Co 2		Co 3		Co 1	
	Healthy	Inoculated	Healthy	Inoculated	Healthy	Inoculated
0	2·56	2·79	3·37	3·01	4·00	3·91
12 h	2·00	2·01	2·50	2·10	3·90	3·65
1	1·80	1·42	2·00	2·20	3·82	3·60
3	1·29	1·33	1·55	2·15	3·87	3·47
5	1·45	1·60	1·24	2·29	3·52	1·38
10	1·90	2·41	1·90	1·80	3·33	1·27

* mg/g of dry tissue

	CD (P=0·05)
Variety	0·16
Inoculation	0·13
Interaction	0·54

The participation of this pathway greatly enables a ready marshalling of oxidizable substrates for generating energy. Marimuthu[1] also reported that the variety Co 2 contained more of phenolics and recorded greater accumulation of both total and O.D. phenols due to inoculation than in the susceptible ones.

Further, tissues containing greater reserve of oxidizable sugars are often more prone to pathogenic invasion than those containing lower reserve or *vice versa* leading to the conept of 'high ' and 'low' sugar diseases in plants[13]. Recently, Moses *et al.*[14] observed that the cv. IR 8, susceptible to *X. oryzae*, contained greater amounts of total and reducing sugars which is in coformity with the present findings.

The gradual increase in the level of fructose in the moderately resistant cv. Co 2 and a reduction in the highly susceptible variety might be due to the proliferation of the pathogen in the susceptible variety which might have warranted the utilization of fructose apart from glucose.

In conclusion, it may be stated that the susceptibility of the greengram cultivar Co 1 is due to high level of reducing sugars and the resistance due to low level of the glucose.

The senior author is grateful to the CSIR, New Delhi, for the award of a Senior Research Fellowship and to Tamil Nadu Agricultural University for providing facilities to carry out the work.

December 1, 1980,

1. Marimuthu, T., *Doctoral Thesis*, TNAU, Coimbatore, India, 1978.
2. Allen, P. J., *Annu. Rev. Plant Physiol.*, 1954, 5, 225.
3. Vidhyasekaran, P., *Doctoral Thesis*, TNAU, Coimbatore, India, 1972.
4. Purushothaman, D., *Doctoral Thesis*, Annamalai University, Annmalainagar, India, 1971.
5. Király, Z., *Methods in Plant Pathology with Special Reference to Breeding for Disease Resistance*, Elsevier Sci. Pub. Co., London, 1974.
6. Romanowski, R. D., Kuć, J. and Quackenbush, F. W., *Phytopathology*, 1962, **52**, 1259.
7. Inman, R. E., *Ibid.*, 1962, **52**, 1207.
8. Nelson, N., *J. Biol. Chem.*, 1944, **153**, 375.
9. Barton, L. V., *Contrib. Boyce Thompson Inst.*, 1961, **21**, 147.
10. Yemm, E. W. and Willis, A. J., *Biochem. J.*, 1954, **57**, 508.
11. Uritani, I., *The Comm. Agr. Expt. Sta. Bull.*, 1963, **663**, 4.
12. Heitefuss, R. and Williams, P. H. (ed.), *Encyclopedia of Plant Physiology*, Springer-Verlag, Berlin, 1976, Vol. 4.
13. Horsfall, J. G. and Dimond, A. E., *Plant Pathology—An Advanced Treatise*, Academic Press, New York, 1959, Vol. 1.
14. Moses, G. J., Rao, Y. P. and Siddiq, E. A., *Indian Phytopath.*, 1975, **28**, 508.