EFFECT OF RED ROT INFECTION IN SUGARCANE VAR. Co. 86032 AND Co. 265

S. S. PATIL

Department of Botany, Doodhsakhar Mahavidyalaya, Bidri

ABSTRACT

Sugarcane is commercially grown in India for sugar production. The crop is affected by red rot caused by Colletotrichum falcatum Went. leading to severe yield loss. A study was undertaken to assess the impact of red rot on biochemical parameters of sugarcane var. Co 86032 and Co. 265 under field conditions. The result showed that primary photosynthetic pigments were reduced by 22.19 % and 16.09 % respectively compared to healthy leaves.. Infection caused a reduction in soluble sugar content accompanied by an increase in leaf starch content.

INTRODUCTION

Diseases affecting cash crops like sugarcane is a serious and challenging problem as the diseased plants become less and less productive. The early maturing varieties of sugarcane Co. 86032 and Co. 265 are susceptible to red rot caused due to *Colletotrichum falcatum* Went.. It has been thought worthwhile to investigate metabolic changes induced by biotic stress due to red rot infection. Therefore an attempt has been made to analyse organic constituents such as chlorophylls, polyphenols, proline and carbohydrate contents, juice quality analysis and phenolic compounds from healthy and infected leaf tissue.

MATERIALS AND METHODS

Healthy and infected plants (5 Months old) of sugarcane var. Co.86032 and Co. 265 were collected from the experimental fields plots of Shree Dudhganga-Vedganga Sahakari Sakhar Karkhana, Ltd. Bidri (Maharashtra) and randomly sampled plants were used for experimental purpose.

Chlorophylls were estimated by Witham et.al. (1971) Proline, polyphenols, carbohydrates were estimated by the methods suggested and used by Bates et.al (1973), Folin and Dennis (1915) and Nelson (1944) respectively.

Juice quality analysed as per the method described by Spencer and Meade (1945) and phenolic compounds were estimated by the method of Glass and Bohm (1969) by running two dimensional paper chromatography.

RESLUTS AND DISCUSSION

Chlorophylls are essential components for photosynthesis and occur in chloroplasts as green pigments in all photosynthetic plant tissues. The values of chlorophyll a, chlorophyll b, total chlorophylls and chlorophyll a/b ratio analysed from healthy and infected sugarcane leaf tissue of clones Co 86032 and Co 265 are depicted in Table 1. It is evident from the table that the red rot infection adversely affects the total chlorophylls in sugarcane leaves. The reduction in total chlorophyll contents were 22.19 % and 16.09 % in Co 86032 and Co 265 respectively as compared with control. The reduction in chlorophyll contents may be due to loss of structural integrity of chloroplast (Mitra and Sengupta, 1980), lowered rate of synthesis and accelerated breakdown (Duggal et.al., 1991), increased activity of chlorophyllase (Srinivasan, 1982), low concentration of magnesium, manganese and nitrogen (Ananthnarayan and Rao,1980) and toxic metabolites released by pathogen (Pero and Main,1970). Many reports on fungal infection have also noted similar trends i.e. reduction in contents of photosynthetic pigments (Moriondo et.al.2005; Mandal et. al. 2009; Kulkarni et.al.2009; Sinha and Srivastava, 2010). This loss of chlorophyll will ultimately affect the process of photosynthesis and productivity.

The proline contents depicted in Table. 2. Free proline is said to play a role in plants under biotic and abiotic stress conditions Verbruggen and Hermans (2008). It is now well established that the proline is stress product synthesized in response to drought and said to be osmotic substance (especially cytoplasmic osmoticum) during water stress (Boggess et.al.1976). Though the molecular mechanism has not yet been established for the increased level of proline, one of the hypotheses refers to breakdown of protein into amino acids and conversion to proline for storage. Many workers have reported a several-fold increase in the proline content under physiological and pathological stress conditions (Kavi Kishor, 2005). Its accumulation under different types of stresses such as water (Mika et.al.2005), salt (Cavalieri and Huang, 1979), temperature , moisture (Singh and Singh, 1988), have been reported. It also accumulates due to biotic stress (Mohanty and Sridhar, 1982). In the present investigation in clone Co 265, proline content was increased in red rot infected leaves which may be due to disease (Biotic) stress. Whereas clone Co 86032 showed no accumulation and hence may be regarded as resistant for red rot as far as proline is concerned while Co 265 is susceptible to red rot. Our observations are also quite similar to that of Sinha et.al.(1984) and Bhansali et.al. (1986). The reduction of proline due to biotic stress has also been reported (Ramlingam, 1987).

The values of polyphenols in healthy and infected leaves of sugarcane are depicted in Table 2. It is vividly clear from the table that clone Co 265 infected with red rot showed increase in polyphenols while clone Co 86032 showed no accumulation of polyphenols. The increased level of polyphenols in leaves may be attributed to fungal infection as phenols have been reported to accumulate with almost every infection or mechanical damage (Farkas and Kirale, 1962). It has been observed that phenol accumulation takes place in all infected tissues because it is defensive mechanism adopted by the host plant (Sindhan et.al.1999). Several reasons have been ascribed for the accumulation of polyphenols in diseased plants such as, increased activity of polyphenol oxidase (Srinivasulu et.al., 1981), increased contents of copper and zinc (Sasikumaran et. al. 1979) are worth mentioning. All the above mentioned factors may either individually or collectively contribute for greater analysis of polyphenols of healthy and infected leaves of sugarcane clone Co 265. To support this paper chromatogram of phenolic compounds of healthy and infected leaves of clone Co 86032 and Co 265 were estimated, where maximum phenolic compounds were observed in infected plant leaves as compared with healthy ones. Clone Co 86032 showed more phenolic compounds and less polyphenol contents in infected leaf tissue require further study which is in progress.

The carbohydrate contents (Table.3) in healthy and red rot infected leaves of sugarcane var. Co 86032 and Co 265 were analysed. The carbohydrate analysis exhibited increased reducing sugar contents while decrease in total sugars, non-reducing sugars, total carbohydrates. No consistency was observed in starch content in both Co 86032 and Co 265 healthy and infected leaf tissue. Increased level of starch was exhibited by Co 265 infected leaf tissue while there is no change in Co 86032. In general, it is observed that lower organisms like fungal pathogens utilize readymade carbohydrates for their growth and development due to autotrophic properties and hence they have to depend upon host plants for carbohydrates. From the available reports it has been observed that infection increases reducing sugar contents though in some cases it decreases (Beniwal and Satayvir 1989;Sindhan et.al. 1999). Maximum (30%) reduction in total sugar contents in infected leaves was exhibited by clone Co 265. Non-reducing sugars were reduced much in Co 86032 (37%) than that of Co 265 (25%). Similarly total carbohydrates were reduced more in Co 86032 (17.59%) than that of Co 265 (2.72%). The above findings are in support with Basra et. al.(1985). Lower concentrations of soluble sugars in the downy mildew infected leaves have been reported (Sharma and Rajpurohit 2004). However, higher starch content in the infected leaves may be due to poor phloem loading.

On the other hand, elevated starch content might cause feedback inhibition of photosynthesis as observed in apple affected by zonal chlorosis (Cheng and Cheng 2004).

The juice quality analysis studied in healthy and infected sugarcane var. Co 86032 and Co 265 are depicted in Table 3. It is clear from the table that red rot infection caused reduction in brix percentage. This reduction in brix was (4.62%) in clone Co 265 and (12-08%) in Co 86032. The reduction in purity coefficient was maximum (3%) in Co 265 and minimum in Co 86032 (0.045%) in infected. Earlier studies on losses in juice quality parameter due to red rot have also indicated substantial reduction in these parameters (Beniwal et.al.,1989).

SUMMARY AND CONCLUSION

Diseases affecting cash crops like sugarcane is serious and challenging problem as the diseased plants become less and less productive.

Chlorophyll contents in red rot infection exhibit reduced pattern.

Biotic stress of red rot infection caused accumulation of proline and polyphenols in clone Co 86032, it can be correlated with its disease resistant capacity.

Red rot infection caused reduction in reducing sugar, decrease in total sugars, non-reducing sugar and total carbohydrate content in both the clones.

Reduction in juice quality parameters was more in clone Co 86032 than that of Co 265.

REFERENCES :

Ananthnarayan R S and Rao B V (1980) Effect of magnesium on total chlorophyll content of hybrid maize, Curr. Res.,9(1) : 8-9.

Basra R K, Kaur S. and Dhillon M. (1985) Anatomical and biochemical studies of the resistance and susceptibility of groundnut var. to *Cercospora* leaf spot, Ann. Bio., 1(1) : 7-12.

Bates L.S., Walden R.D. and Teare I.D. (1973) Rapid determination of free proline for water stress studies, Plant and Soil, 39 :205-207.

Beniwal M.S. and Satayvir (1989), Effect of red rot on juice quality of sugarcane, Indian Phytopath. 42(2) : 292.

Beniwal M.S. Satayvir and Taneja A.D. (1989), Effect of red rot on juice quality of sugarcane, Indian Sugar, September 1989 : 403-406.

Bhansali R.R., Sinha O.K. and Kishan Singh (1986), Accumulation of free proline in sugarcane leaf infected with *Colletotrichum falcatum*. Indian Phytopath. 36(2): 367-368.

Boggess S.E., Aspinall D and Paleg L.G. (1976) Stress metabolism IX. The significance of end product inhibition of proline biosynthesis and of compartmentation in relation to stress induced proline accumulation, Aust. J. Plant. Physiol.,3 : 513-525.

Bowden R.L. and Rouse D.T. (1987) Effect of *Verticillium dahliae* on photosynthesis and transpiration of potato. Phytopath.,77: 1703

Cavalieri A.J. and Huang A.H.C. (1979), Evaluation of proline accumulation in the adaptation of diverse species of marsh halophytes to the saline environment, Amm. J. Bot. 66 : 307- 312.

Cheng, L.S., and Cheng, L. 2004: CO2 assimilation, carbohydrate metabolism, xanthophylls cycle, and the antioxidant system of 'Honeycrisp' apple leaves with zonal chlorosis. J. Am. Soc.Hortic. Sci. **129**, 729-737.

Duggal S. Singh R.A. and Lakhanpal T.N. (1991). Physiological studies on potato virus infected *Capsicum pendulum* plants I. Indian Journal of Mycol. and Plant Pathol., 11:84-88.

Farkas G. and Kirale, (1962). Enzymological aspects of plant diseases. I. Oxidative enzymes. Phytopathol. Z., 31: 251-252.

Folin O. and Dennis W.(1915). A colorometric method for determinations of phenols and phenol derivatives in urine J. Biol. Chem., 22: 305-308.

Ghose L., Neela F.A. Chakravorty T.C., Ali M.R. and Alsam M.S. (2009) Incidence of leaf blight disease of mulberry plant and assessment of changes in amino acids and photosynthetic pigments of infected leaf

Glass A.D. and Bohm B.A.(1969) The accumulation of cinnamic acid and benzoic acid derivatives in *Pteridium aquilinum* and *Athyrium felix-feming* Phytochem., 8 : 371-377.

Jarvis P.G. (1971). The estimation of resistance of carbon dioxide transfer In : Plant photosynthetic production, Manual of methods, Pb. The Hague : 566-631.

Kavi Kishor P.B., S. Sangam1, R. N. Amrutha1, P. Sri Laxmi1, K. R. Naidu,K. R. S. S. Rao, Sreenath Rao, K. J. Reddy, P. Theriappan and N. Sreenivasulu (2005) Regulation of proline biosynthesis, degradation, uptake and transport in higher plants: Its implications in plant growth and abiotic stress tolerance. Current Science, 88(3) – 424-438

Kulkarni S., Benagi V. I., Patil P.V., Hegde Y., Konda C. R., Deshpande V. K.(2009) Sources of resistance to anthracnose in green gram and biochemical parameters for resistance Karnataka j. Agric. Sci., 22 (5) (1123-1125):

Mandal K., Saravanan,R; Maiti, S and Kothari I.L. 2009: Effect of downy mildew disease on photosynthesis and chlorophyll fluorescence in *Plantago ovata* Forsk. Journal of Plant Diseases and Protection, 116 (4), 164–168,

Mika Yamada, Hiromasa Morishita, Kaoru Urano, Noriko Shiozaki, Kazuko Yamaguchi Shinozaki, Kazuo Shinozaki and Yoshu Yoshiba (2005) Effects of free proline accumulation in petunias under drought stress Journal of Experimental Botany 2005 56(417):1975-1981

Mitra D.K. and Sengupta U.K.(1980) Influence of little leaf disease on photosynthesis and chlorophyll content in brinjal (*Solanum melongena* Linn.) leaf tissue. Ann. Agric. Res., 1: 108-111.

Mohanty S.K. and Sridhar R.(1982). Physiology of rice tungro virus diseases; proline accumulation due to infection. Physiol. Plant,56: 89-93.

Moriondo, M., S. Orlandini, A. Giuntoli, M. bindi, 2005: The effect of downy and powdery mildew on grapevine (*Vitis vinifera* L.) leaf gas exchange. J. Phytopathol. **153,** 350-357.

Nelson N.(1944). A photosynthetic adaptation of Somogyi method for determination of glucose. J. Biol. Chem., 153:379-380.

Pero R.W. and Main C.E.(1970).Chlorosis of tobacco induced by A*lternaria* monoethyl ether produced by *Alternaria tennis*. Phytopath., 66: 1570-1573.

Raghvendra A.S. (1986). Suppression of stomatal opening in isolated abaxial adaxial epidermis of *Commelina benghalensis* by proline, G-substances and methyl jasmonate. Nat. Sem. On Plant Physiol. and Biochem.

Ramlingam P (1987). Changes in amino acids of healthy and *Rhizoctini*a *solani* rice tissue. Comp. Physiol. Ecol., 12: 89-90

Sasikumaran S., Kandaswamy T.K. and Vidhyasekaran P. (1979). Physiology of tomato plants affected by leaf curl virus. Indian Phytopath.,32: 352-359.

Sharma, M.P., and Rajpurohit, D 2004: Biochemical alterations in isabgol leaves in response to fungicidal control of downy mildew. J. Mycol. Plant Pathol. **34**, 130-132.

Sindhan, G. S., Indra Hooda and Parashar, R. D.,(1999), Sources of resistance of Cercospora leaf spot in mungbean and biochemical parameters for resistance. J. Mycol. Pl. Path., 29: 130-132.

Singh N. B. and Singh R.G. (1988) Proline and dry matter accumulation in sugarcane under moisture stress. Indian J. Plant Physiol., 29 :171-174.

Sinha A. and Srivastava M. (2010) Biochemical changes in Mungbean plants infected by mungbean yellow mosaic virus International J. of Virology, 6: 150-157

Sinha O.K., Bhansali R.R and Kishan Singh (1984). Free proline accumulation in response to infection by *Colletotrichum* in sugarcane. Curr. Science. 53: 493-494

Spencer G.L. and Meade G.P. (1945). Cane sugar Handbook. John Viley and sons.

Srinivasan N. (1982). Significance of deranged chlorohyllase, chlorophyll system associated with yellow leaf disease of arecanut. Indian Phytopath.,35 : 530-531

Srinivasulu P. Raja B. C. and Nayudu M.(1981). Effect of striate mosaic virus infection on nitrogen fractions, phenols, ascorbic acid and oxidative enzymes of sugarcane leaves. Indian J. of Microbiol., 21: 351-353

Verbruggen Nathalie and Hermans Christian (2008) Proline accumulation in plants: a review Amino Acids Volume 35(4).

Witham F H ,Blaydes D F and Devlin R M (1971) Experiment in Plant Physiology Van Nostrand New York p.245

Table 1. Effect of red rot infection on chlorophyll contents.

Variety	Chl- a	Chl-b	Total Chlorophylls	Chl a / b ratio
	mg / 100 g fresh tissue			
Co 86032				
Healthy	134.4 ± 3.2	56.17 ± 0.43	190.51 ± 2.9	2.39
Infected	106.09 ± 2.1	42.13 ± 0.9	148.22 ± 2.04	2.52
Co 265				
Healthy	154.53 ± 1.4	69.75 ±0.94	224.28 ± 0.92	2.21
Infected	135.51 ± 2.2	52.68 ± 0.52	188.19 ± 2.02	2.57

Table 2. Effect of red rot infection on proline and polyphenol contents.

Variety	Proline contents	Polyphenol contents
	µ mole / g dry tissue	g / 100g dry tissue
Co 86032		
Healthy	117.64 ± 0 .94	0.857 ± 0.05
Infected	76.12 ± 0.23	0.805 ± 0.05
Co 265		
Healthy	58.82 ± 0.71	0.77 ±0.006
Infected	103.80 ± 3.2	1.22 ±0.09

Table 3. Effect of red rot infection on carbohydrate contents (g/100g dry tissue) and juice quality.

Variety	Reducing sugar	Non-reducing sugar	Total sugars	Starch	Total carbohydrate	Observed brix (%)	Corrected brix (%)	Pole (%)	Purity coefficient (%)
Co 86032									
Healthy S.D	0.025± 0.0001	0.27± 0.003	0.30± 0.08	0.48± 0.002	1.08± 0.008	23.4± 1.98	23.66± 1.05	18.88± 0.9	87.71± 1.005
Infected S.D	0.038± 0.0002	0.17± 0.005	0.21± 0.059	0.47± 0.007	0.89± 0.003	20.11± 0.982	20.8± 1.02	16.64± 1.05	87.31± 0.98
Co 265									
Healthy S.D	0.74± 0.0056	0.20± 0.001	0.27± 0.006	0.56± 0.001	1.10± 0.08	21.6± 1.05	21.83± 4.03	17.46± 1.2	91.22± 1.76
Infected S.D	0.08± 0.0002	0.15± 0.003	0.23± 0.0056	0.60± 0.004	1.07± 0.008	20.6± 2.5	20.82± 2.71	16.65± 1.05	88.48± 1.88