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Influence of nitrogen fertilisation on the incidence of sheath rot disease of paddy

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Abstract. The influence of three levels of nitrogen on the incidence of sheath rot disease of paddy caused by *Sarocladium attenuatum* was studied under field conditions using one resistant (Bhavani) and one susceptible (Kannaki) variety. Nitrogen nutrition of the host influenced the disease incidence. The total and OD phenols were much less in the susceptible variety than in the resistant variety. Further, Bhavani had less quantities of soluble carbohydrates, total nitrogen, ammoniacal nitrogen and protein nitrogen. Phenols accumulated in the infected plants, while the reducing and non-reducing sugars and different nitrogen fractions decreased.

Keywords. *Sarocladium attenuatum*; total and OD phenols; soluble carbohydrates; nitrogen fractions.

1. Introduction

Sheath rot disease of rice incited by *Sarocladium attenuatum* is a serious disease of rice causing yield losses up to the tune of 57% in South India.

The increased susceptibility of crop plants to pathogens due to excessive application of nitrogenous fertilisers is well demonstrated (Rangaswami 1972). The increasing use of high levels of nitrogenous fertilisers to maximise yields from nitrogen responsive high yielding rice variety has necessitated a study of the influence of nitrogenous fertilisers on host-parasite relationship of the sheath rot pathogen. This paper deals with the effect of different doses of nitrogen on the host physiology and its susceptibility/resistance to the pathogen.

2. Materials and methods

Two varieties of rice, viz., Kannaki (susceptible) and Bhavani (resistant) were used for pathophysiological studies. These varieties were raised in the field with three levels of nitrogen, viz., 0 N, 65 N and 100 N kg/ha and were spray inoculated with the spore suspension of the pathogen (*ca* 10^7 spores/ml) when the plants were 80 days old. Uninoculated (healthy) plants were also maintained for each level of

N application as checks. The infected and healthy sheaths from both the varieties were analysed for biochemical changes after the full disease development.

Five grams of leaf sheath samples of the two varieties were chopped and extracted with 80% boiling ethanol (Chandramohan *et al* 1967). From the ethanol extract, the total (Bray and Thorpe 1954) and *Ortho*-dihydroxy phenols (Johnson and Schaal 1957) reducing (Nelson 1944) and non-reducing sugars (Inman 1965) were estimated. The total nitrogen (Humphries 1956), ammoniacal nitrogen and non-protein nitrogen (Pregal 1945) were also estimated.

3. Results and discussion

3.1 *Phenol metabolism in response to S. attenuatum infection*

The results (table 1) reveal that application of higher dose of N decreased the total and *ortho*-dihydroxy phenols both in the susceptible and resistant varieties. Infection by the pathogen led to the accumulation of phenols in the tissue. In the resistant variety, Bhavani, more phenols accumulated than in the susceptible, Kannaki. Rice cultivar, Co 29 resistant to *Pyricularia oryzae* contained more total phenols than the susceptible Co 13 (Sridhar 1970).

Admittedly this relationship leads to the view that varieties which are resistant to pathogens contain more amounts of phenols (Kosuge 1969). A number of papers have been published (Flood and Kirkham 1960; Sridhar 1970) to indicate that increased nitrogen nutrition of the plant reduced the toxicity of phenols. Reduction in phenolics due to nitrogen nutrition has also been recorded (Kiraly 1964).

3.2. *Sugar metabolism*

Soluble carbohydrates increased in both Kannaki and Bhavani rice varieties due to increased N application. The susceptible variety contained more sugars than the resistant one. Sugars provide the carbon skeleton for the synthesis of phenolics (Goodman *et al* 1967) and the decreased sugar content in the resistant variety can be attributed to the increased phenolic content, in that, infection by the pathogen tended to decrease the sugar levels in both the varieties.

High amounts of reducing and non-reducing sugars have been recorded in many plants, susceptible to several pathogens (Otani 1959; Jayapal and Mahadevan 1968). In several host-parasite interactions, the levels of tissue sugars decrease, following infection (Asada 1957; Inman 1965; Dayal and Joshi 1968). The sugars, besides being channelled for the synthesis of phenolics serve as energy source for the pathogen.

3.3. *Nitrogen metabolism*

Nitrogen is well known to increase the susceptibility of crop plants to certain pathogens (Appa Rao 1956; Rangaswami 1972). Increased application of nitrogen enhanced tissue nitrogen in both the cultivars. The quantity of total and other fractions of nitrogen estimated was more in Kannaki than in Bhavani. The changes in the levels of soluble and insoluble nitrogenous fractions of the susceptible and resistant host tissue due to pathogenic invasion have been studied in detail (Asada

Table 1. Changes in phenols soluble carbohydrates and nitrogen fractions due to *Sarocladium attenuatum* infection.

		N Levels					
		0 N		65 N		100 N	
		H	I	H	I	H	I
Total phenols*	Kannaki	2·12	2 27	1 81	2 08	1·76	1·96
	Bhavani	2·51	2·62	2·03	2·41	2·27	2·88
O D Phenols*	Kannaki	0·86	0·95	0·84	0·81	0·86	0·89
	Bhavani	1·13	1·27	0·93	1·02	0·74	0·78
Reducing sugars**	Kannaki	4·81	4·42	5·13	4·50	6·46	6·02
	Bhavani	4·96	4·87	5·05	4·67	6·42	5·76
Non-reducing sugars**	Kannaki	2·07	2·00	2·88	2·74	3·40	3·45
	Bhavani	1·98	1·50	2·92	2·42	3·26	3·01
Total nitrogen***	Kannaki	0·714	0·694	1·824	1·823	2·146	2·131
	Bhavani	0·660	0·642	1·432	1·345	1·552	1·540
Ammoniacal nitrogen***	Kannaki	0·102	0·102	0·241	0·223	0·327	0·290
	Bhavani	0·088	0·089	0·293	0·265	0·243	0·230
Non-protein nitrogen***	Kannaki	0·046	0·049	0·157	0·183	0·141	0·129
	Bhavani	0·062	0·054	0·126	0·137	0·139	0·228
Protein nitrogen***	Kannaki	0·668	0·645	1·667	1·640	2·005	2·002
	Bhavani	0·598	0·588	1·306	1·208	1·413	1·322

The data represent the average of five estimates

H—Healthy
I—Infected

* Phenols in catechol equivalents;
** Sugars in glucose equivalent;
*** Nitrogen in percentage dry weight basis.

1957; Barnett 1959; Shaw and Colotelo 1961; Uritani and Stahmann 1961). Pathogen inoculation decreased slightly the total nitrogen and other fractions of N. Bhaskaran *et al* (1975) also reported the same in cotton leaves infected with *Alternaria macrospora*. The more pronounced reduction of ammoniacal nitrogen may be attributed to the utilisation of the same by the pathogen for its growth. In vitro studies of the pathogen indicated that N in ammoniacal form induced more toxin production than N in the nitrate form. It is therefore reasonable to believe that ammoniacal N plays an important role in disease susceptibility. This observation finds support from the studies of Vidhyasekaran (1972) in helminthosporiose of finger millet.

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