

Original Research Article

Biochemical Defence Mechanism in Direct Seeded and Transplanted Rice against Blast of Paddy

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ABSTRACT

Paddy blast disease caused by *Pyricularia oryzae* (*Magnaporthe oryzae*) causes significant yield loss in North Eastern Karnataka. This study was conducted to know the biochemical defence mechanism on direct seeded and compared to transplanted rice ecosystem at 30, 60 and 90 DAS. Phenol content increased after pathogen infection in both ecosystem but more phenol accumulation was found in DSR sample than that of TPR. Protein content increased was observed after pathogen infection but more increased was recorded in the TPR ecosystem than in DSR ecosystem. At 60 and 90 DAS 3.35 mg/g and 2.82 mg/g recorded in healthy sample and 5.08 mg/g and 4.39 mg/g in diseased leaf samples from DSR ecosystem, healthy sample 3.20 mg/g and 2.41 mg/g and diseased samples recorded 5.48 mg/g and 5.01 mg/g was observed in TPR ecosystem respectively. Total sugar content was less in diseased samples when compared to healthy samples in both DSR and TPR ecosystems. At 60 and 90 DAS 14.83 mg/g and 17.06 mg/g recorded from healthy samples and 5.01 mg/g and 4.07 mg/g from diseased samples of DSR field, 16.28 mg/g and 18.24 mg/g from healthy leaf samples was observed in TPR and 4.04 mg/g and 3.32 mg/g was observed from diseased samples from both at 60 and 90 DAS respectively. Chlorophyll content was higher in the TPR sample than that of DSR sample which encourages more prone to disease development in TPR ecosystem.

Keywords

Direct seeded rice,
Transplanted rice,
bio chemicals,
blast, defence
mechanism

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops of family Poaceae. About 90 per cent of world's rice is produced and consumed in Asia alone.

Direct-seeded rice (DSR) is a feasible alternative to conventional puddled transplanted rice with good potential to save water, reduce labour requirement, mitigate green-house gas (GHG) emission and adapt to climatic risks. The yields are comparable with transplanted rice if crop is properly managed. In recent years, efforts have been

made in promoting the DSR technology by various organizations (Pathak *et al.*, 2011). Rice is one of the diverse crops grown in different agro-climatic conditions and is the second largest cereal in the world. More than 90 per cent of the world's rice area is in Asia, which is the home for more than half of world's poor and more than half of world's rice cultivators (Rao, 2010). At the beginning of 1990s, annual production of rice was around 350 million tonnes. By the end of the century it had reached 410 million tonnes.

Materials and Methods

Variation in the biochemical contents of infected and healthy plants in transplanted and direct seeded rice were studied by estimation of carbohydrates, proteins, phenolic compounds and chlorophyll a and b production in DSR and TPR ecosystems at different stages of 30, 60 and 90 DAS by following the standard procedure as mentioned below.

Extraction of plant tissues in alcohol

Extraction of leaves from the sample and then clarification of the extract to remove the pigments like chlorophyll. Estimation of metabolites requires their complete extraction from the tissues. The activities of the enzymes which synthesize and utilize them need to be stopped at once to get reliable values. Plant constituents possess different solvents. Though, water is the universal solvent, it does not penetrate the tissue quickly enough to stop the enzymatic activity. In this context alcohol (80%) was the suitable solvent for the extraction.

Estimation of Total phenol

The total phenols present in plant samples was estimated by following Folin-Ciocalteu reagent method (Bray and Thorpe, 1954).

Estimation of Total protein

Protein estimation was done by following the procedure of Lowry *et al.*, (1951). Bovine serum albumin was used as the standard.

Estimation of Total sugar

The total sugar was estimated after acid hydrolysis of non-reducing to reducing

sugar by following Nelson's modification of Somogyi's method (Nelson, 1944).

Estimation of Chlorophyll content

Total chlorophyll, chlorophyll a and chlorophyll b contents were determined following the method of Arnon (1949).

The chlorophyll content was estimated using the following formula.

$$\text{Chlorophyll a (mg/g r. wt.)} = 12.7 (A663) - 2.69 (A645) \times (V/100 \times w \times a)$$

$$\text{Chlorophyll b (mg/g r. wt.)} = 22.9 (A645) - 4.68 (A663) \times (V/100 \times w \times a)$$

$$\text{Total chlorophyll (mg/g r. wt.)} = 20.2 \times A645 + 8.02 \times A663 \times (V/100 \times w \times a)$$

Results and Discussion

Rice plant response to blast disease infection varied due to changes in the management practices. Changes in the biochemical parameters of rice plant grown in DSR and TPR ecosystem were monitored in healthy and diseased leaf samples of 30, 60 and 90 DAS and results of estimated parameters were compared and mentioned in the table 1.

Phenol content increased after pathogen infection in both ecosystem but more phenol accumulation was found in DSR sample than that of TPR. At 30 days after sowing phenol content in DSR diseased leaf sample was 2.18 mg/g and it was decreased in case of healthy sample (0.88 mg/g). In TPR at 30 DAS 1.81 mg/g was found in diseased sample and 0.67 mg/g found in healthy sample where as at 60 and 90 DAS 1.75 mg/g and 1.43 mg/g weight found in DSR diseased samples and 0.72 mg/g and 0.70 mg/g was found in healthy samples respectively, In TPR 1.23 mg/g and 1.08

mg/g found in diseased sample whereas 0.58 mg/g and 0.42 mg/g was in healthy samples at 60 and 90 DAS respectively. Phenol content from DSR healthy plant was found higher compared to TPR as it contain high sugar but in diseased plant of TPR phenol deposition was high than DSR diseased plant. This is mainly due to colonization of the pathogen in the TPR enhanced by sugar which later enhances more phenol production. DSR plant has higher phenol content in the initial stage of the pathogen infection, it makes host plant resistant to pathogen in the early stage of infection as phenol content enhances the resistance levels of the plant. Higher the phenol content more resistance is offered and less phenol content with high sugar content increase the susceptibility. Increase in phenol content offered resistance were correlated with earlier workers. (Sathiyathan and Vidyashekar, 1981; Arora and Wagle, 1985; Luthra *et al.*, 1988 and Saini *et al.*, 1988; Ganguly 1995; Sivakumar and Sharma, 2003).

Protein content increased was observed after pathogen infection but more increased was recorded in the TPR ecosystem than in DSR ecosystem. At 30 DAS protein content was more in diseased samples (5.56 mg/g) and 6.32 mg/g of both DSR and in TPR respectively. In healthy samples 4.90 mg/g and 4.12 mg/g was observed in DSR and in TPR ecosystem. Whereas at 60 and 90 DAS 3.35 mg/g and 2.82 mg/g recorded in healthy sample and 5.08 mg/g and 4.39 mg/g in diseased leaf samples from DSR ecosystem, healthy sample 3.20 mg/g and 2.41 mg/g and diseased samples recorded 5.48 mg/g and 5.01 mg/g was observed in TPR ecosystem at 60 and 90 DAS respectively. Protein content reduction was higher in the TPR blast infected sample than DSR diseased plants even though there was same level of protein content in healthy

sample of DSR and TPR. Similar results were reported by earlier workers (Malhotra 1993; Nandagopal 1995; Ravikumar *et al.*, 1995; Byregowda 1997 and Mishra *et al.*, 2010).

Total sugar content was less in diseased samples when compared to healthy samples in both DSR and TPR ecosystems. At 30 DAS in DSR as well as in TPR total sugar content was more in healthy leaf samples 12.56 mg/g and 13.27 mg/g whereas diseased leaf samples recorded less in both the ecosystems 6.32 mg/g and 4.08 mg/g. At 60 and 90 DAS 14.83 mg/g and 17.06 mg/g recorded from healthy samples and 5.01 mg/g and 4.07 mg/g from diseased samples of DSR field, 16.28 mg/g and 18.24 mg/g from healthy leaf samples was observed in TPR and 4.04 mg/g and 3.32 mg/g was observed from diseased samples from both at 60 and 90 DAS respectively. Primarily sugar content was higher in the TPR samples than that of DSR sample which encourages more pathogen infection occurs in TPR sample it favours more disease development and plant become more succulent for the disease attack. Irrespective of the ecosystem, sugar content reduction was observed but the reduction was found more in TPR ecosystem. Similar results with respect sugar content reduction due to pathogen infection was reported by several workers (Goodman *et al.*, 1967; Sindhan *et al.*, 1999 and Chakarbarthy *et al.*, 2002). In general, the total chlorophyll, chlorophyll A and chlorophyll B contents were less in diseased samples when compared to healthy samples irrespective of ecosystems. Total chlorophyll estimation studies revealed that chlorophyll content in healthy rice leaf from DSR is 0.31 mg/g and diseased 0.102 mg/g and in TPR healthy sample contents 0.40 mg/g and in diseased 0.120 mg/g at 30 DAS, There is no much difference between DSR and in TPR diseased samples.

Table.1 Biochemical parameters of rice in diseased (caused by blast) and healthy leaf samples at 30, 60 and 90 DAS

Biochemical parameters	30 DAYS				60 DAYS				90 DAYS			
	DSR		TPR		DSR		TPR		DSR		TPR	
	Healthy	Diseased										
Total sugar	12.56	6.32	13.27	4.08	14.83	5.01	16.28	4.04	17.06	4.07	18.24	3.32
Free phenols	0.88	2.18	0.67	1.81	0.72	1.75	0.58	1.23	0.70	1.43	0.42	1.08
Soluble proteins	4.90	5.56	4.12	6.32	3.35	5.08	3.20	5.48	2.82	4.39	2.41	5.01
Chlorophyll content												
A	0.16	0.053	0.21	0.061	0.13	0.050	0.19	0.058	0.12	0.043	0.18	0.056
B	0.15	0.049	0.19	0.059	0.14	0.047	0.14	0.043	0.12	0.042	0.15	0.048
(A+B)	0.31	0.102	0.40	0.120	0.27	0.097	0.33	0.101	0.24	0.085	0.33	0.104

Whereas at 60 and 90 DAS healthy samples from DSR recorded 0.27 mg/g and 0.24 mg/g, in diseased samples recorded 0.097 mg/g and 0.085 mg/g respectively. In case of TPR healthy samples observed 0.33 mg/g and 0.33 mg/g, where in diseased samples 0.101 mg/g and 104mg/g were recorded at 60 and 90 DAS respectively. Chlorophyll content was higher in the TPR sample than that of DSR sample which encourages more prone to disease development in TPR ecosystem. Chlorophyll and sugar content decrease drastically in the TPR than DSR, because DSR sample contains less of sugar and chlorophyll so it is less prone to pathogen infection on DSR samples. Similar results on reduction of chlorophyll content after pathogen infection was obtained by earlier workers (Subramanyan *et al.*, 1976; Upadhyay and Dwivedi, 1979; Kaur and Dhilon, 1990).

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