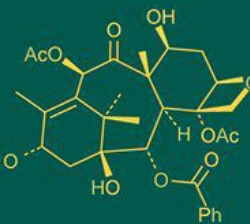
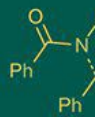
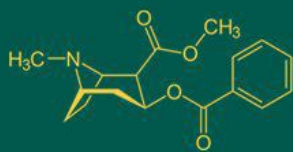


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(3): 1006-1012
www.biochemjournal.com
Received: 03-01-2026
Accepted: 07-02-2026

Akurathi Ramya
Department of Plant
Pathology, Agricultural
College, Bapatla, Andhra
Pradesh, India

Emmadi Venu
Division of Plant Pathology,
ICAR-IARI, New Delhi,
Delhi, India

Eden K
Department of Plant
Pathology, Agricultural
College, Bapatla, Andhra
Pradesh, India

Prasanna Kumari V
Professor and Head,
Department of Plant
Pathology, Agricultural
College, Bapatla, Andhra
Pradesh, India

Srinivas Prasad M
Principal Scientist,
Department of Plant
Pathology, ICAR-IIRR,
Rajendranagar, Hyderabad,
Telangana, India

Corresponding Author:
Akurathi Ramya
Department of Plant
Pathology, Agricultural
College, Bapatla, Andhra
Pradesh, India

Enzymatic antioxidant responses in resistant and susceptible rice genotypes due to blast infection

Akurathi Ramya, Emmadi Venu, Eden K, Prasanna Kumari V and Srinivas Prasad M

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i3SI.8204>

Abstract

Rice blast, caused by *Pyricularia oryzae*, is one of the most destructive diseases of rice, leading to substantial yield losses worldwide. The present study was conducted under greenhouse conditions at ICAR-IIRR to investigate the biochemical responses associated with blast resistance in rice genotypes. Five rice genotypes were evaluated for the activity of key defense-related enzymes, namely peroxidase (POX) and superoxide dismutase (SOD), at different time intervals (0, 24, 48, 72, and 96 hours) following inoculation with *P. oryzae*. The results revealed a significant increase in enzyme activity in resistant genotypes compared to susceptible ones. Maximum peroxidase activity was observed at 72 hours after inoculation in DRR Dhan 62, followed by NLR 34449, indicating a strong defense response. Similarly, superoxide dismutase activity peaked at 48 hours after inoculation in NLR 34449. In contrast, the susceptible genotype BPT 5204 exhibited the lowest enzyme induction for both POX and SOD throughout the observation period. Overall, the enhanced activity of these antioxidant enzymes in resistant genotypes suggests their crucial role in conferring resistance against rice blast disease. These findings contribute to a better understanding of the biochemical mechanisms underlying host resistance and may aid in the development of blast-resistant rice cultivars.

Keywords: Rice (*Oryza sativa* L.), *Pyricularia oryzae*, Peroxidase, Superoxide dismutase, resistant, susceptible

Introduction

Rice (*Oryza sativa* L.) serves as a major food source for more than half of the world's population and is cultivated worldwide (Uppala and Zhou, 2018) [20]. Global rice production estimate in 2022-2023 remains as 503.0 million tons and productivity of 5.66 metric tons of productivity per hectare (FAOSTAT, 2022). It is one of the most significant global food grain crops, serving as a primary source of revenue and employment across the world. Rice is the staple food, and global rice demand is estimated rise to 852 million tons in 2035 (Khush, 2013) [12]. It is one of the most important crops globally and is being cultivated from temperate to tropical zones (Seck *et al.*, 2012) [18]. But future projections indicate that the current levels of production are not ample to feed the increasing population of the country. In order to match the food demands in future, concerted attempts should be made to increase the rice productivity and minimize production losses due to pests and diseases. In India, rice is cultivated in an area of 43.66 million hectares with a total production and productivity of 125 million tons and 2.72 metric tons per hectare, respectively. (www.usda.gov.in). In India, West Bengal, Punjab, Tamil Nadu, Uttar Pradesh, and Andhra Pradesh are the principal rice-producing states. Rice crop is affected by more than thirty-five diseases caused by fungi, bacteria and viruses, which are known to be the major factors for low yield of rice in the world. Among various diseases limiting rice productivity, blast, caused by *Pyricularia oryzae* Cavara, is a devastating disease that causes 80% loss in yields under favorable conditions and necessitates its management. Blast is the most significant and destructive disease that affects rice crops globally, this illness results in yield losses each year that are sufficient to feed more than 60 million people. Divya *et al.* (2014) [7].

In plants, there are defence mechanisms such as biochemical processes and gene-for-gene recognition (Andersen *et al.*, 2018; Wu *et al.*, 2021) [3, 21]. By boosting the enzymatic activity of peroxidase (POX), the enzyme that catalyses lignin production, systemic resistance

induction stimulates defensive response pathways in plants. Liposaccharides, a component of cell wall membranes, are also increased by induced systemic resistance (ISR) induction (Radjacommar *et al.*, 2004)^[17]. Reactive oxygen species (ROS) levels and the severity of oxidative damage are significantly influenced by the degree of coordination among ROS-scavenging enzymes (Liang *et al.*, 2003)^[14]. Fungicides and the development of resistant types are the two most popular methods for treating blast. Use of resistant varieties is an appropriate measure to control the rice blast disease. Though many resistant varieties to *M. oryzae* have been developed, the resistance is not long lasting, because the high pathogen plasticity in the fields makes single resistance gene break down after three to five years of the cultivar release (Bonman *et al.*, 1986)^[6]. Hence, development of broad spectrum and durable blast resistant varieties is needed for combating this disease, which requires continuous efforts of pathologists and breeders.

Materials and Methods

Five genotypes in rice were selected for the present study and relevant information are furnished below.

Isolation and purification of *M. oryzae*

Rice blast-causing fungus *M. oryzae* was isolated in the symptoms appearing on leaves of susceptible varieties. Both the pathogen-infected and healthy leaf segments were chopped into 1.5 cm pieces and surface sterilised with a 0.1 percent mercuric chloride solution before being washed with sterile distilled water. Using sterilised filter paper, these leaf tissues were dried and placed on Petri dishes with Oat meal agar (OMA) medium. Mycelial growth was seen on these plates after seven days of incubation at 26±2°C. Single spore isolation approach was used for further purification. In order to preserve the pure isolate for future research, PDA slants were used (Ou, 1985)^[16].

Sporulation and Blast Induction in Rice Plants

The leaf bits of paragrass weed are collected from the field and cut into small pieces of 1-5cm length. A cotton swab was placed in 150ml flask to maintain humidity. Thereafter 15gm of each host bits were placed on cotton swab and sterilized at 121°C for 20min at 15 lb pressure. Each flask was inoculated with 25mm diameter mycelial discs of IIRR isolates and incubated for 15 days at room temperature to prepare spore suspension, each species stem and leaf bits were crushed in 50ml sterile distilled water using sterile pestle and mortar. The spore count was assessed at 10DAI (Days after incubation) and 15DAI using a haemocytometre and data obtained was represented in conidia/cell. The investigation was conducted utilising 5 rice genotypes (NLR-34449, DRR-DHAN-62, Rasi, HR-12, BPT-5204). Upon adding the pathogen to 25 ml of sterile water, shaking vigorously, and decanting the spore suspension. Using an automizer, the decanted spore solution with 2×10^3 per ml was sprayed on 21day-old rice seedlings. After 21 days after sowing the blast fungus *Magnaporthe grisea* was inoculated and plastic trays were covered with perforated small plastic sheets, and these sheets were employed to function as a barrier against this source and to maintain the humidity level necessary for the fungus development at a later stage when the inoculum would be given. To guarantee appropriate aeration, perforations were placed in the sheet. The International Rice Research Institute, Philippines (IRRI, 2002) created the standard evaluation scale (SES) for

evaluating plants exhibiting leaf blast symptoms. The leaf samples were taken 24,48,72 hrs and kept at -20 °C.

Bioassay of defense related enzymes

The samples were were challenge inoculated with *M. oryzae*. Samples were collected at 24, 48, 72 hours interval 21days after the pathogen inoculation. Two enzymes were estimated viz., Peroxidase and Superoxide dismutase. Using potassium phosphate buffer, the peroxidase enzyme source was made, and hydrogen peroxide was used to make the reaction mixture. The enzyme activity was noted at 436nm was recorded at 60seconds interval in spectrophotometer. Enzyme free extract is used as a blank. Enzyme activity was expressed in units/min/g fresh weight of the sample (Sengar and Chaudhary, 2014)^[19].

$$\text{Units/min/g fresh weight} = \frac{\text{Change in absorbance /minute} \times \text{Total volume (ml)}}{\text{Extinction coefficient} \times \text{Volume of sample taken (ml)}}$$

$$\text{Extinction coefficient} \times \text{Volume of sample taken (ml)}$$

$$\text{Extinction coefficient} = 2.8 \text{ mM}^{-1} \text{ cm}^{-1}.$$

Peroxidase activity was assessed spectrophotometrically following the method given by Putter (1974). The enzyme activity was noted at 436nm. Enzyme activity was expressed in units/L of enzyme extract.

$$\text{Enzyme activity units/l} = \frac{3.18 \times 0.1 \times 1000}{6.39 \times 1 \times \text{minutes to increase the absorbance by } 0.1 \times 0.1}$$

$$6.39 \times 1 \times \text{minutes to increase the absorbance by } 0.1 \times 0.1$$

A significantly modified method initially published by Beauchamp and Fridovich (1971)^[5] is used to conveniently assess SOD (Madamanchi *et al.*, 1994)^[15]. 1g of a fresh sample is ground in a pre-chilled mortar and pestle at 4 °C with 10 mL of a 50 mM potassium phosphate buffer (pH: 7.8). The sample is then centrifuged at 10,000 rpm for 10 minutes at 4 °C. Grab the supernatant. Maintain in a deep freezer. Within 12 hours after the enzyme extraction, the supernatant was utilized. A test tube was filled with 50 mL of enzyme extract, 0.6 mL of 250 mM potassium phosphate buffer, 0.39 mL of 100 mM methionine, 0.0006 mL of 10 mM riboflavin, 0.06 mL of 5 mM EDTA, and 0.3 mL of 750 mM NBT. Freshly prepare the cocktail mixture and place it under the fluorescent light for 15 minutes. After 15 minutes of exposure to a 40W bulb in each tube, by using the kinetics approach, read the absorbance (OD) at 340 nm on the UV-VIS spectrophotometer was immediately measured. The spectrophotometer is calibrated using a preparation devoid of enzyme extract and NBT used as a "blank." A different control with NBT but no enzyme extract should be used as the reference control. One unit of SOD activity is defined as the 50% inhibition of the interaction between riboflavin and NBT in the presence of methionine. Change in absorbance was recorded at 340nm at 30seconds interval. The enzyme activity was expressed in units/ ml enzyme extract.

Results and Discussion

Phenolic compounds are the foremost important factors that are responsible for the physiological, metabolic and biochemical activities in plants. The different concentrations of phenolic compounds are the major factors for resistance and susceptibility against the diseases. These phenolic

compounds got oxidised by the peroxidase which accumulates in response to infection. The enzymes Peroxidase and superoxide dismutase were estimated as the change in the absorbance. The biochemical assay was conducted to find out the role of defense related enzymes like peroxidase and super oxide dismutase (SOD) in defense against challenge inoculation of *Pyricularia oryzae* on five different rice cultivars representing the resistant and susceptible genotypes. In this experiment, the leaf blast pathogen was inoculated artificially on five different varieties namely Rasi, DRR Dhan 62, BPT 5204, NLR

34449 and HR 12 after they attaining 20 days of seedling stage in uniform blast nursery. The peroxidase activity was measured before the challenging inoculation with *Pyricularia oryzae* and after 24, 48, 72 and 96 hours after inoculation (Table 1). The enzyme peroxidase activity was estimated as the change in the absorbance and presented in the table 1. The change in the absorbance for the peroxidase was shown significant variation for the peroxidase enzyme among the five varieties tested and across the different time periods (Fig.1).

Table 1: Peroxidase activity in different rice cultivars after challenge inoculation with *Pyricularia oryzae*

S.no	Variety	Peroxidase activity (units/l of enzyme extract)				
		0 hours	24 hours	48 hours	72 hours	96 hours
1	Rasi	761.41 (27.60)	930.61(30.51)	1765.01(42.01)	930.61(30.51)	801.22(28.31)
2	DRR DHAN 62	778.00(27.90)	2363.85(48.62)	2420.25(49.20)	2438.50(49.38)	1146.26(33.86)
3	BPT 5204	703.35(26.53)	938.90(30.65)	1672.11(40.89)	902.41(30.04)	703.35(26.53)
4	NLR 34449	782.97(27.99)	1285.60(35.86)	2058.62(45.37)	1957.43(44.24)	1104.79(33.24)
5	HR 12	549.08 (23.44)	514.24 (22.68)	1625.67 (40.32)	857.62 (29.29)	680.13 (26.08)
	Mean	714.96 (26.74)	1206.64 (34.74)	1908.33 (43.69)	1417.32 (37.65)	887.15 (29.79)
	SE(m)±	0.71	0.86	1.05	0.94	0.81
	C.D (P<0.05)	2.24	2.73	3.31	2.97	2.57
	CV (%)	4.61	4.32	4.16	4.33	4.75

Values are mean of three replications, Figures in parentheses represent square root transformation.

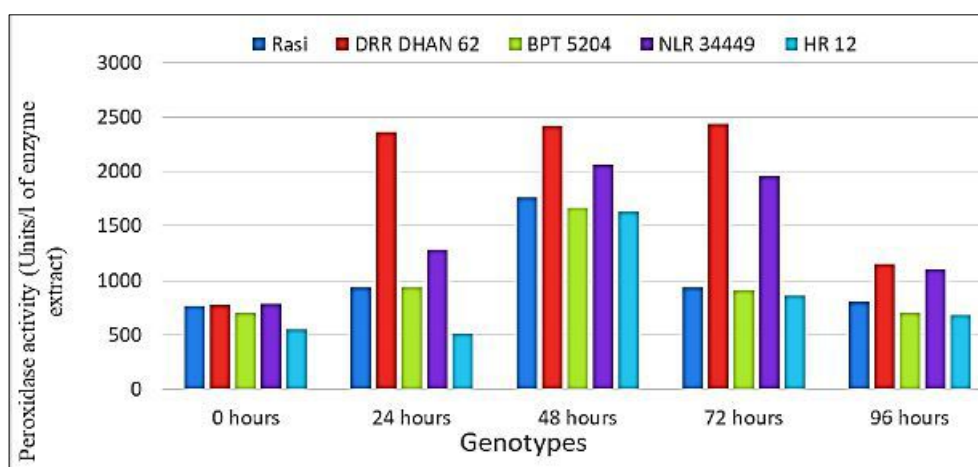


Fig 1: Peroxidase activity (Units/l of enzyme extract) in different rice cultivars after challenge inoculation with *Pyricularia oryzae*

The peroxidase activity profile ranged between 549.08 to 2438.50 units/l of enzyme extract in the infected leaves of all the five different varieties. The peroxidase activity was increased at 48 hours to inoculation and decreased at 72 hours after inoculation with some exceptions. The peroxidase activity was significantly induced by 68 % and 62% increase in the infected samples of DRR Dhan-62 (2438.50 units/l of enzyme extract) and NLR-34449 (2058.62 units/l of enzyme extract) varieties which were showing resistance to blast pathogen and the least level of induction of the peroxidase activity was recorded in the susceptible varieties like BPT 5204 and HR-12. The highest activity of peroxidase was recorded for DRR Dhan-62 at 72 hours after inoculation (2438.50 units/l of enzyme extract) followed by the NLR-34449 (2058.62 units/l of enzyme extract) which are resistant to rice blast pathogen and the lowest induction was recorded in BPT-5204 (1672.11 units/l of enzyme extract) and HR-12 (1625.67 units/l of enzyme extract). Irrespective of the variety, all the genotypes showed increased activity of peroxidase after 48 hours of inoculation with blast pathogen and thereby decreasing

trend as observed from 72 hours and 96 hours after challenge inoculation. This result coincide with result of study conducted by Keshgond R S and Lingaraju (2016) [11], where peroxidase activity was found higher in resistant pigeonpea variety WRP-1 and lower in susceptible variety GS-1 during interaction of *Fusarium udum* and *Heterodera cajani* pathogens. The reports of study conducted by Kumar *et al.* (2013) [13] revealing increased activity of peroxidase enzyme from initial phase of the infection of *P. oryzae* in PB-21 rice genotype is in accordance with the present study results. In rice, Agrawal *et al.* (2003) [1] reported cytosolic ascorbate peroxidase genes are up-regulated upon wounding suggesting that the cytosolic ascorbate peroxidase isozymes play a protective role against stressful conditions such as pathogen attack. Hence, ascorbate peroxidases play an important role in the defense response. In plant systems, peroxidase plays a major role in synthesis of plant cell wall and the enzyme which cross-links phenolic residues in cell wall. Polysaccharides and glycoproteins used to strengthen the cell wall components. This action may represent a part of wound-healing response. Some peroxidase isoenzymes

were induced by stress such as high salt, physical wounding and microorganisms.

Like peroxidase the SOD activity was recorded at 24, 48, 72 and 96 hours after challenging inoculation of *Pyricularia*

oryzae in the five different varieties. The activity of SOD was recorded as the change in the absorbance and shown in the table 2 and fig. 2.

Table 2: Estimation of Superoxide dismutase (SOD) activity in different rice cultivars after challenging inoculation with *Pyricularia oryzae*

S.no	Variety	Superoxide dismutase activity (units/gram fresh weight)				
		0 hours	24 hours	48 hours	72 hours	96 hours
1	Rasi	0.18 (0.82)	11.48 (3.46)	12.84 (3.65)	15.77 (4.03)	13.53 (3.74)
2	DRR DHAN 62	0.15 (0.80)	6.38 (2.62)	29.43 (5.47)	19.43 (4.46)	19.32 (4.45)
3	BPT 5204	0.34 (0.91)	4.15 (2.15)	6.80 (2.70)	10.59 (3.33)	8.55 (3.00)
4	NLR 34449	0.13 (0.79)	11.67 (3.48)	38.47 (6.24)	21.75 (4.71)	19.56 (4.47)
5	HR 12	0.21(0.84)	9.31 (3.13)	16.23 (4.09)	14.42 (3.86)	10.57 (3.32)
	Mean	0.21(0.84)	8.59 (3.01)	20.75 (4.60)	16.39 (4.10)	14.31 (3.84)
	SE(m)±	0.0033	0.0212	0.11	0.10	0.08
	C.D. (P ≤ 0.05)	0.0104	0.0668	0.37	0.31	0.26
	CV (%)	1.26	1.25	4.49	4.27	3.84

Values are mean of three replications, Figures in parentheses represent square root transformation.

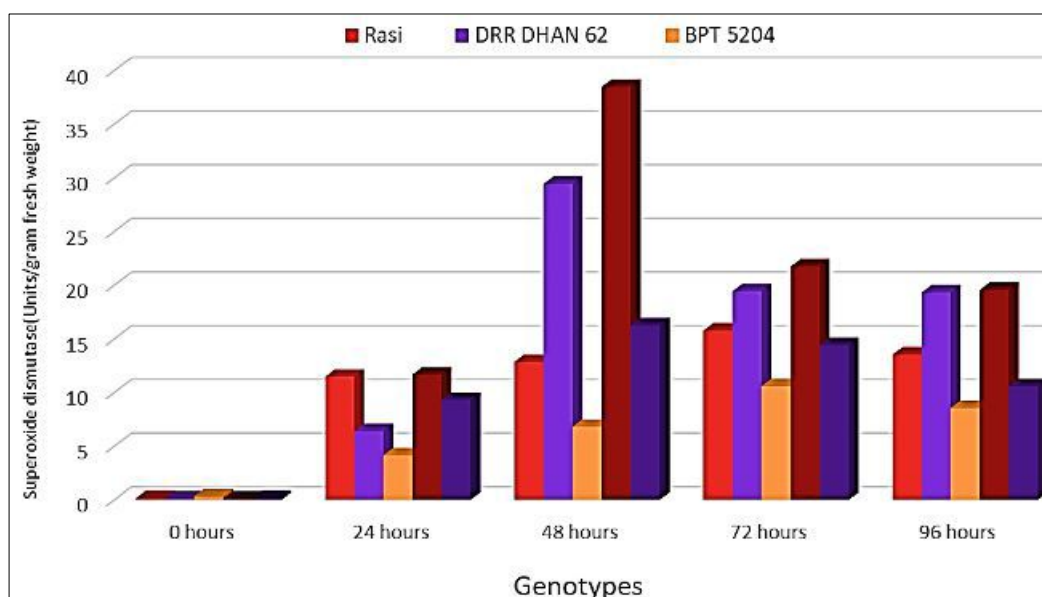


Fig 2: Estimation of Superoxide dismutase (SOD) activity in different rice cultivars after challenging inoculation with *Pyricularia oryzae*

The SOD activity was followed the same trend like peroxidase activity as the induction of the enzyme was increased at 48 hours after challenging inoculation with the rice blast fungus and thereafter there was decreasing SOD activity was observed from 72 hours after inoculation (Table 2). There was a significant difference existed for the SOD activity among the varieties tested after challenging inoculation with the *Pyricularia oryzae*. The highest induction SOD was recorded at 48 hours after inoculation in NLR 34449 (38.473 units/gram fresh weight) followed by DRR Dhan 62 (29.437 units/gram fresh weight) and the lowest induction of SOD was observed in BPT 5204 (6.801 units/gram fresh weight) at 48 hours after inoculation. There was a 4.7-fold increase in the SOD activity was observed in DRR Dhan 62 from inoculation to 48 hours after inoculation and 3.3-fold increase was observed in the case of NLR 34449. But incase susceptible varieties like BPT 5204, 1.64-fold increase was observed followed by 1.74-fold in the variety HR12. So, the fold of increase in the activity of SOD shall be used as a criterion for selection of the resistant variety in the screening studies. The enzyme SOD constitutes the first line of defence against ROS by catalysing the dismutation of O_2^- to O_2 and H_2O_2 (Alscher *et al.* 2002) [2]. In our study, SOD activity was significantly

induced in infected leaf of both blast-resistant and susceptible rice genotypes (Table 2). POX enzymes remain active in elimination of ROS and catalyse the oxidoreduction of various substrates using hydrogen peroxide. Many reports have suggested POX plays a role in resistance to pathogens (Kawaoka *et al.* 2003) [10]. In our study, POX activities also increased significantly up to 48 hours, suggesting that POX could be important for resistance. SOD and POX showed similar trends (Table 1 and 2), thus these two enzymes might be more efficiently control ROS. Similar study on superoxide dismutase activity by Anushree *et al.* (2016) [4] reported concurring results to the present study revealing the highest superoxide dismutase activity in blast pathogen inoculated resistant rice variety KJT-5 and lowest in inoculated susceptible variety Ek-70. The enzyme superoxide dismutase constitutes the first line of defence against ROS by catalyzing the dismutation of O_2^- to O_2 and H_2O_2 (Alscher *et al.* 2002) [2]. In table 3, showing the trend of enzymatic activity from the inoculation to 96 hours. It is showing that there was a increase in the activity of both POX and SOD in both the susceptible and resistant varieties, but the amount of increase was more in resistant varieties compared to the susceptible variety. The peroxidase activity was more in DRR Dhan-62 (2438 units/l

of enzyme extract) compared to the variety HR-12 (1625.67 units/l of enzyme extract). Similarly, the activity of SOD was more in DRR Dhan-62 (29.44 units/gram fresh weight) compared to the susceptible variety HR-12 (16.22 units/gram fresh weight). So, the increased activity of these

defence related enzymes gives the clarity of resistance and susceptibility. POX activity increased significantly in all resistant and susceptible genotypes suggesting their activation more efficiently in for scavenging of ROS during pathogen attack.

Table 3: Estimation of activity of Peroxidase and superoxide dismutase in resistant and susceptible varieties

Genotypes	DRR DHAN 62		HR 12	
Days	POX	SOD	POX	SOD
Before inoculation	778.00 (27.90)	0.15 (0.80)	549.08 (23.44)	0.21 (0.84)
Day 1	2363.85 (48.62)	6.38 (2.62)	514.24 (22.68)	9.31(3.13)
Day 2	2420.25 (49.20)	29.44 (5.47)	1625.67 (40.32)	16.24 (4.09)
Day 3	2438.50 (49.38)	19.44(4.46)	857.62 (29.29)	14.42 (3.86)
Day 4	1146.26 (33.86)	19.32 (4.45)	680.13 (26.08)	10.58 (3.32)
Mean	1829.372 (42.77)	14.946 (3.93)	845.348 (29.08)	10.152 (3.26)
SE(m)±	0.97	0.08	0.50	0.09
C.D(P 0.05)	3.07	0.26	1.5930	0.30
CV (%)	3.95	3.733	3.011	4.26

* Values are mean of three replications, Figures in parentheses represent square root transformation

POX- Peroxidase, SOD- superoxide dismutase

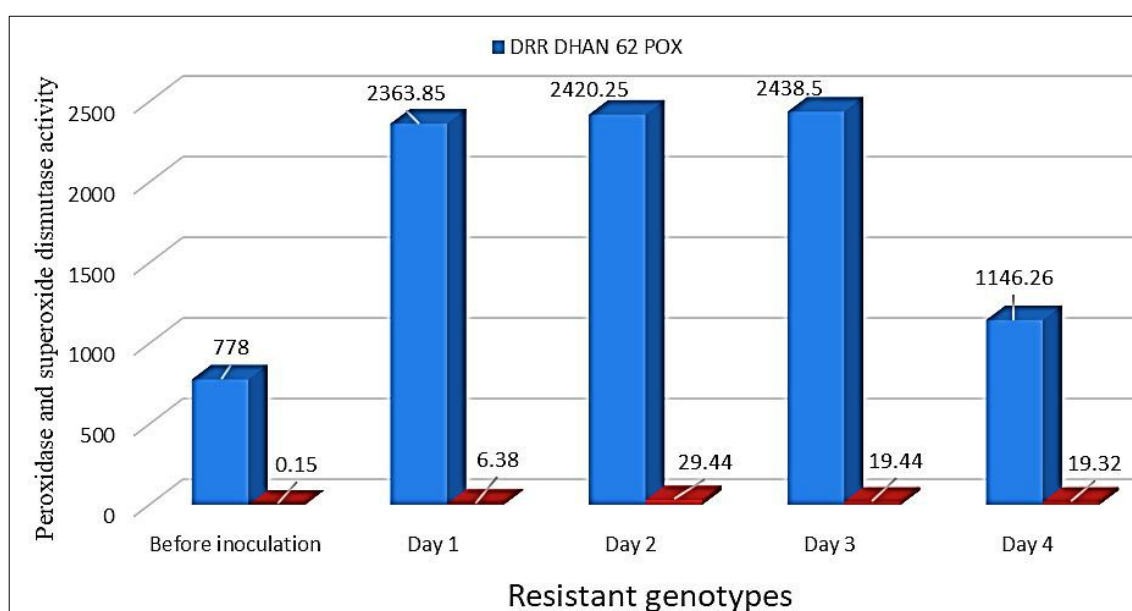


Fig 3: Activity of Peroxidase (Units/l of enzyme extract) and superoxide dismutase (units/gram fresh weight) in resistant genotype

Table 4: Disease incidence, progression of the disease and rate of infection

S. No	Variety	Percent disease index										AUDPC	Rate of infection (Units/day)
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9			
1	Rasi	0.00 (0.33)	5.56 (13.63)	11.11 (19.47)	17.78 (24.94)	22.22 (28.13)	26.67 (31.09)	31.11 (33.90)	38.89 (38.58)	43.33 (41.17)	175	0.37	
2	DRR Dhan 62	2.22 (8.57)	7.78 (16.19)	11.11 (19.47)	14.44 (22.34)	20.00 (26.57)	22.22 (28.13)	26.67 (31.09)	30.00 (33.21)	30.00 (33.21)	149	0.23	
3	BPT 5204	37.78 (37.93)	45.56 (42.45)	51.11 (45.64)	56.67 (48.83)	58.89 (50.12)	66.67 (54.74)	70.00 (56.79)	75.56 (60.37)	86.67 (68.58)	506	0.29	
4	NLR 34449	1.11 (6.05)	5.56 (13.63)	10.00 (18.43)	11.11 (19.47)	14.44 (22.34)	18.89 (25.76)	24.44 (29.63)	28.89 (32.51)	31.11 (33.90)	130	0.29	
5	HR 12	34.44 (35.94)	41.11 (39.88)	47.78 (43.73)	48.89 (44.36)	57.78 (49.47)	63.33 (52.73)	68.89 (56.10)	78.89 (32.65)	95.56 (77.83)	960	0.49	
Mean		15.11	21.11	22.22	29.77	34.66	39.55	44.22	50.44	53.33	384	0.33	
SE(m)±		0.42	0.37	0.53	0.21	0.64	0.46	0.84	0.83	0.66	1.50	0.03	
C.D. (P<.05)		1.32	1.18	1.67	0.66	2.04	1.47	2.64	2.63	2.08	4.73	0.01	
CV (%)		3.51	1.99	3.21	0.44	3.63	1.66	4.79	4.16	2.30	1.76	0.09	

Values in the parantheses are arc sine transformed values; AUDPC- Area under disease progress curve

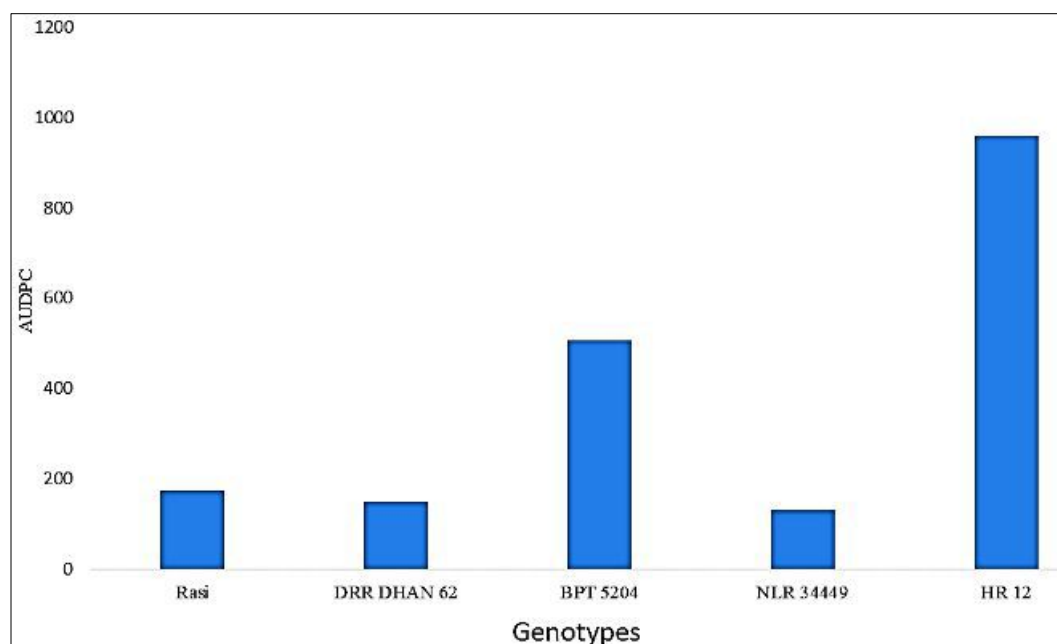


Fig 4: Area under disease progress curve of the five different genotypes

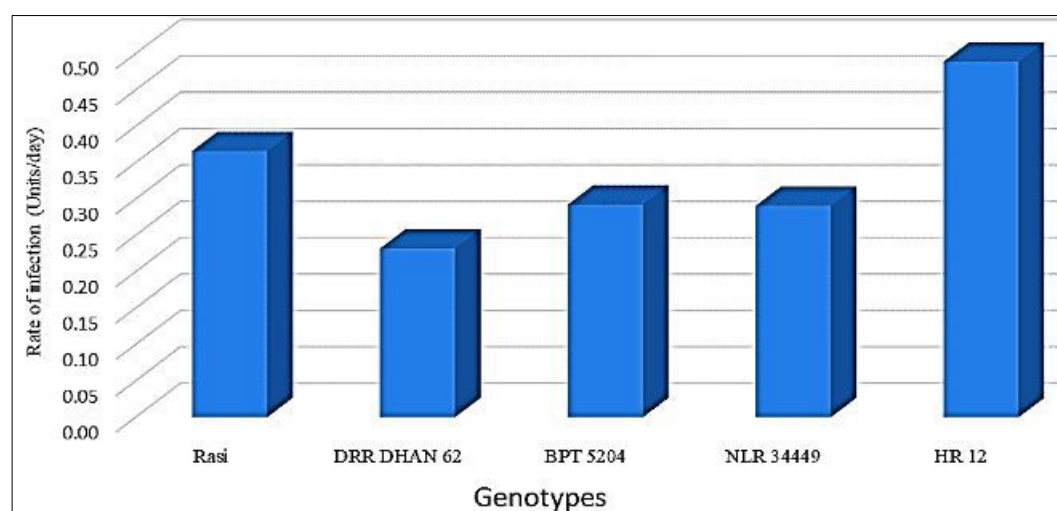


Fig 5: Rate of infection of the rice blast disease in different genotypes

Table 4, shows that there was a significant difference between varieties for the disease severity that is progressing day by day. The highest percent disease incidence was noticed in the variety HR-12 (PDI 95.56%) after 9th day of inoculation followed by the variety BPT-5204 (PDI 86.67%). These two varieties showed highest susceptible reaction in the screening. The lowest percent of disease incidence was recorded in the variety DRR Dhan-62 (PDI 30%) after 9th day of inoculation followed by the variety NLR-34449 (PDI 31.11%). The highest Area under disease progress curve was recorded in the variety HR-12 (960) followed by the Variety BPT-5204 (506) and the lowest Area under disease progress curve was observed in the variety NLR-34449 (130) followed by the DRR Dhan-62 (149), (Fig.4). The enzymatic activity was highly correlated with the disease reaction, as the resistance varieties showed the highest enzymatic activity. Based on the disease progress from the day of inoculation to the 9th day after inoculation, calculated the apparent rate of infection in all the five varieties tested. The rate of infection was more in highly susceptible variety HR-12 (0.49 units/day) followed by the variety Rasi (0.37 units/day). The apparent infection

rate was very low in the variety DRR Dhan-62 (0.23 units/day) followed by the variety NLR-34449 (0.29 units/day).

Conclusion

The present study highlights that the induction of defense-related enzymes, particularly peroxidase (POX) and superoxide dismutase (SOD), plays a key role in conferring resistance to rice blast caused by *Pyricularia oryzae*. Resistant genotypes such as DRR Dhan 62 and NLR 34449 exhibited higher and timely enzyme activity, especially during the early stages of infection (48-72 hours), which contributed to effective scavenging of reactive oxygen species and restriction of disease development. In contrast, susceptible genotypes like BPT 5204 and HR-12 showed comparatively lower enzyme activity along with higher disease incidence and faster infection rates. The clear association between enhanced enzymatic activity and reduced disease severity suggests that POX and SOD can be used as reliable biochemical markers for screening rice genotypes. These findings can support breeding programs aimed at developing durable blast-resistant rice varieties.

References

1. Agrawal GK, Jwa NS, Iwahashi H, Rakwal R. Importance of ascorbate peroxidases OsAPX1 and OsAPX2 in the rice pathogen response pathways and growth and reproduction revealed by their transcriptional profiling. *Gene*. 2003;322:93-103.
2. Alscher RG, Erturk N, Heath LS. Role of superoxide dismutases (SODs) in controlling oxidative stress in plants. *Journal of Experimental Botany*. 2002;53(372):1331-1341.
3. Andersen EJ, Ali S, Byamukama E, Yen Y, Nepal MP. Disease resistance mechanisms in plants. *Genes*. 2018;9(7):339.
4. Anushree PU, Naik RM, Satbhai RD. Activity profile of defence-related enzymes in rice genotypes (*Oryza sativa* L.) against rice blast (*Magnaporthe oryzae*). *Archives of Phytopathology and Plant Protection*. 2016;49(7-8):167-181.
5. Beauchamp C, Fridovich I. Superoxide dismutase: improved assays and an assay applicable to acrylamide gels. *Analytical Biochemistry*. 1971;44(1):276-287.
6. Bonman JM, Bandong JM, Lee EJ, Valent B. Race specific partial resistance to blast in temperate Japonica rice cultivars. *Plant Disease*. 1986;73:496-499.
7. Divya B, Robin S, Rabindran R, Senthil S, Raveendran M, Joel AJ. Marker assisted backcross breeding approach to improve blast resistance in Indian rice (*Oryza sativa*) variety ADT43. *Euphytica*. 2014;200:61-77.
8. FAOSTAT. Food and Agriculture Organization of the United Nations. Rome, Italy; 2022.
9. IRRI. Standard evaluation system for rice. International Rice Research Institute. Philippines; 2002:1-45.
10. Kawaoka A, Matsunaga E, Endo S, Kondo S, Yoshida K, Shinmyo A, Ebinuma H. Ectopic expression of a horseradish peroxidase enhances growth rate and increases oxidative stress resistance in hybrid aspen. *Plant Physiology*. 2003;132:1177-1185.
11. Keshgond RS, Lingaraju S. Studies on biochemical changes in *Fusarium* wilt resistant and susceptible genotypes during *Fusarium udum* and *Heterodera cajani* interaction in pigeonpea. *Journal of Pure and Applied Microbiology*. 2016;10(2):1-10.
12. Khush GS. Strategies for increasing the yield potential of cereals: case of rice as an example. *Plant Breeding*. 2013;132(5):433-436.
13. Kumar S, Elanchezhian R, Singh SS, Singh AK, Mall AK, Sangle UR, Sundaram PK. Field screening of rice genotypes for resistance against bacterial leaf blight and brown spot under aerobic condition. *Journal of Plant Disease Sciences*. 2013;8(2):148-152.
14. Liang Y, Fotiadis D, Maeda T, Maeda A, Modzelewska A, Filipek S, Palczewski K. Rhodopsin signaling and organization in heterozygote rhodopsin knockout mice. *Journal of Biological Chemistry*. 2004;279(46):48189-48196.
15. Madamanchi NR, Donahue JV, Cramer CI, Alscher RG, Pedersen K. Differential response of CuZn superoxide dismutase in two pea cultivars during a short-term exposure to sulphur dioxide. *Plant Molecular Biology*. 1994;26:95-103.
16. Ou SH. Rice diseases. International Rice Research Institute. Manila, Philippines; 1985.
17. Radjacommar R, Ramanathan A, Kandan A, Sible GV, Harish S, Samiyappan R. Purification and antifungal activity of chitinase against *Pyricularia grisea* in finger millet. *World Journal of Microbiology and Biotechnology*. 2004;20:251-256.
18. Seck PA, Diagne A, Mohanty S, Wopereis M. Crops that feed the world. 7: Rice. *Food Security*. 2012;4(1):7-24.
19. Sengar RS. Laboratory manual of biochemistry: methods and techniques. New India Publishing Agency; 2014.
20. Uppala S, Zhou XG. Field efficacy of fungicides for management of sheath blight and narrow brown leaf spot of rice. *Journal of Crop Protection*. 2018;104:72-77.
21. Wu J, Zhai Y, Monikh FA, Arenas-Lago D, Grillo R, Vijver MG, Peijnenburg WJ. The differences between the effects of a nanoformulation and a conventional form of atrazine to lettuce: physiological responses, defense mechanisms, and nutrient displacement. *Journal of Agricultural and Food Chemistry*. 2021;69(42):12527-12540.