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Comparative analysis of quantitative and qualitative losses of different cultivars of rice incited by sheath rot disease (*Sarocladium oryzae*) Sawada

DEEPAK BABOO[1], J. P. SRIVASTAVA[2] AND S. K. BISWAS[1]
[1]Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P) India 208002
[2]Department of Plant Pathology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, (U.P.) India 224229

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Rice (*Oryza sativa* L.) belongs to family Poaceae, is a staple food, a way of life for Asian people because more than 250 million house hold depend on the crop. Rice suffers from various types of abiotic and biotic stresses and diseases caused by fungi, bacteria, viruses, phytoplasma, nematodes and non-paracitic disorder are of immense importance. Among fungal diseases, the Blast, Brown spot, Sheath rot, Sheath blight and False smut are very common and cause heavy losses under the condition of eastern U.P. Sheath rot of rice is caused by *Sarocladium oryzae* (Sawada) Games Hawksworth is becoming a serious problem specially for hybrids and their parental lines owing to their longer duration of floret opening providing the conducive conditions for the infection. The yield losses due to this disease have been estimated by various earlier workers ranging between 9.6 to 85%. In view of the above facts, the investigation entitled "Strategies to combat sheath rot (*Sarocladium oryzae*) of rice", was conducted in the Laboratory of Department of Plant Pathology and CRS, Masodha, N. D. University of Agriculture and Technology, Narendra Nagar Kumarganj Ayodhya (U.P.). The experimental findings revealed that infection of sheath rot disease of rice, the reduction in total number of grains/panicle, number of filled grains/panicle, 1000 grains weight, number of discoloured grains/ panicle, germination %, seedling length and vigour index were decreased. Further, the total sugar, reducing sugar as well as non-reducing sugar also decreased. Likewise, the phenol content was increased due to the infection as compared to healthy seeds.

Key words : Rice, Quantitative, Qualitative losses, Sheath rot, Vigour index and Biochemical Changes.

INTRODUCTION

Rice (*Oryza sativa* L.) belong to family Poaceae, is the most important cereal crop of *Kharif* season. It is a major source of food of more than half of the global population. Its cultivation is of immense important for food security of Asia where more than 90% of the rice grown and consumed (Paula Binaka Ferrer, 2011). The focus on the importance of rice in global food security and the necessity to increase rice production and productivity, the year 2004 was celebrated as "International year of rice" with the name of "Rice is life", by the United Nation. Rice is the staple food of more than 70% of our National population and it is back bone of Indian Agriculture.

Email: drdpatel1992@gmail.com

Rice is one of the important crop of the world both in terms of area (163.7 m ha) and production (749.8 m tones). About 90 percent of the world's rice is grown and consumed in Asia and 60 percent of world's population depends on rice for their half of the calorie intake (FAO, Rice Market Monitor, 2015). Rice is contributed about 45 percent in total cereal production of India and is main food source for more than 60 percent population of the country. In India, the crop is cultivated in about 43.90 million hectares area with an annual production of 104.80 million tones and productivity 23.90 q/ha. (Anonymous, 2016). Uttar Pradesh is an important rice growing state, in which rice area is 5.87 million ha and production 12.22 million tones with productivity of 20.82 q/ha (Anonymous, 2015).

Nutritionally, rice contains about 76-85 % carbohydrates, about 8 % protein and several

minerals such as potash, chlorine, phosphorus, calcium, magnesium, sodium and iodine (Juliano, 1980,). Sheath rot of rice is a serious disease accounting for heavy toll of rice production. The disease was first reported in rice from Taiwan by Sawada (Sawada, 1922) and later it was reported from all the countries of South Asia. In India, sheath rot was first reported by Agnihothrudu (1973). Amin *et al.* (1974) also, Gams and Hawksworth identified two species with in the renamed genus namely *Sarocladium oryzae* and *Sarocladium attenuatum*. Symptoms appear on the uppermost leaf sheath enclosing the young panicles. The lesions appear as oblong or somewhat irregular spots with brown margins and grey centres which enlarge and cover most of the leaf sheath, resulting in unemerged or partially emerged panicles having unfilled or partially filled grains were reported by Singh and Dodan (1995).

Severe outbreak of sheath rot causing considerable yield losses was reported from Punjab during 1978-79. In Andhra Pradesh, sheath rot was found to be severe in Godavari, Nellore and Chittoor districts, causing 80 to 85 per cent yield loss (Bhaskar *et. al.,* 2002). Sheath rot disease of rice has emerged as one of the major disease affecting crop in almost all rice-growing ecosystems of the world. It is a serious menace to rice cultivation, causing yield losses ranging from 3 to 85 per cent depending upon disease severity. *Sarocladium oryzae* is primarily seed borne and survives on plant debris and weeds, disseminates conidia through wind and sucking pests. Pathogen produces phytotoxins viz., cerulenin and helvoic acid which are responsible for production of characteristic greyish-brown lesion on flag leaf sheath and discolouration of grains. Dwarf and semi dwarf varieties associated with partially exerted panicles are more susceptible as compared to tall varieties with full panicle exerted varieties. Consequent upon inception of CMS system, problem of sheath rot emerged as major constraint in the quality seed production of rice (Srivastava and Yadav, 2009). Reduction in 1000 grain wt. (10.80-52.58%) and increase in chaffiness (48.07-53.80%) were reported by Sharma *et al.* (2013).

MATERIALS AND METHODS

The healthy and infected seed (earheads) were collected separately. Total number of grains/ panicle, number of infected grains/panicles, number of filled and unfilled grains/panicles were counted separately for each variety.

1000 Seed weight (g)

1000 seed were counted for each variety separately from healthy and infected panicles and weighted through electronic balance.

Germination (%)

Seed germination percent was worked out through paper towel methods (ISTA, 1999).

Towel papers were soaked in tap water, two towel papers were used as substrate and one for covering the seed. Counted number of seed (100 seed) were arranged in concentric ring formation on the base paper and bink with rubber band under butter paper. 100 seed were kept in two layer of moist germination paper and bink with rubber band. Rolled papers were kept vertically in seed germinator at 28±2°C for 7 days. After 7 days of incubation, the germination percent was recorded on the basis of normal, abnormal dead seeds.

Shoot length (cm)

Shoot length of all the 10 varieties were measured through measuring scale. Seedling raised through paper towel method were uprooted carefully and used for the purpose of measurement.

Root length (cm)

Root length were measured of the same seedling of which shoot length was taken earlier.

Seedling length (cm)

The sum total of root-shoot length measured as above was considered as seedling length.

Vigour index

The vigour index was calculated as per method prescribed by Abdul Baki and Anderson (1973) and expressed in whole number. The formula followed was:

Vigour index = Seedling length × Germination %

Total sugar

Total sugar was determined by the method of Dubois *et al*., (1956) using phenol reagent 0.1 ml sugar extract was taken in test tube and volume was made up to 1 ml with addition of distilled water. Then 0.1 ml of 80 per cent phenol and 4 ml conc. H_2SO_4 was added by the side of the test tube and then cooled down at room temperature. The intensity of colour was recorded at 480 nm on Spectronic-20 against blank solution. The calculation was done with the help of standard curve prepared from glucose solution.
Total sugar= Reducing sugar + Non- Reducing sugar

Reducing sugar

Reducing sugar content in grain was determined by the method of Miller (1959). 1 ml sugar extract was mixed with 3 ml dinitro-salicylic acid (DNS), and kept over water bath for 10 minutes. The test tube was collected at room temperature and the intensity of colour was recorded on Spectronic-20 at 575 nm against blank solution. The calculation was done with the help of standard curve prepared from Gallic acid.

Total Phenol content

Total phenolic content in healthy and sheath rot infected grains of rice was analyzed by method as described by Swain and Hillis (1984). Phenol reduces phasphotungus to molybedic acid under alkaline condition to produce blue colour complex which is measured colorimetrical at 750 nm. One gram sample was taken and blended it with 20 ml. 80 per cent alcohol. The whole content was centrifuged at 1000 rpm for 15 minute and supernatant were collected three test tubes for blank standard and biological sample. 1ml. supernatant was taken in a test tube and mixed with phenol reagent (1ml. finally), 2ml sodium carbonate solution was added and made up the volume with 50ml. distilled water. Similarly, blank and standard solution was also prepared by above method taking 1ml gallic acid solution. The intensity of colour was recorded at 750nm. And total phenol content was calculated in mg/100gm sample on the basis of standard curve prepared from Gallic acid.

RESULTS AND DISCUSSION

Total number of grains/panicle

The number of grains/panicle healthy ear head was observed maximum number of grains (171.9) in variety Sarjoo-52 followed by (166.5) in variety MTU-7029 were recorded while minimum number of grains/panicle was recorded (124.5) in variety Susk Samrat singnificant variance were observed regarding the minimum and maximum number of grains/panicle in case of Sarjoo-52 and Susk Samrat.

The number of grains/panicle infected ear head was observed maximum number of grains (154.3) in variety Sarjoo-52 followed by (148.7) in variety MTU-7029 were recorded while minimum number of grains/panicle was recorded (114.2) in variety Susk Samrat significant variance were observed regarding the minimum and maximum number of grains/panicle in case of Sarjoo-52 and Susk Samrat (Table-1).

Percent Reduction in number of grain

The Percent reduction in number of grain was observed maximum number of grains (26.6) in variety BPT-5204 followed by (22.9) in variety NDR-3112 were recorded while minimum percent reduction in number of grain was recorded (8.8) in variety NDR-2065 significant variance were observed regarding the minimum and maximum percent reduction in number of grain in case of BPT-5204 and NDR-2065 (Table-1). The fact that sheath rot increases chaffy ness has been recorded by various workers Damodara Naidu (1994) and Amin *et al.* (1974).

Total number of filled grains/panicle

The number of filled grains/panicle healthy ear head was observed maximum number of filled grains/panicle (152.1) in variety Sarjoo-52 followed by (133.6) in variety MTU-7029 were recorded while minimum number of grains/panicle was recorded (109.6) in variety NDR-359 significant variance were observed regarding the minimum and maximum number of filled grains/panicle in case of Sarjoo-52 and NDR-359.

The number of filled grains/panicle infected ear head was observed maximum number of grains (93.7) in variety Sarjoo-52 followed by (88.2) in variety MTU-7029 were recorded while minimum number of filled grains/panicle was recorded (67.4) in variety Susk Samrat significant variance were observed regarding the minimum and maximum number of filled grains/panicle in case of Sarjoo-

Table 1: Effect of sheath rot disease on quantitative losses

Variety	Total No. of grain/panicle		% reduction in no of grain	No of filled grains		Grain filling %		1000 grain weightt (gm)	
	Healthy	Infected		Healthy	Infected	Healthy	Infected	Healthy	Infected
Susk Samrat	132.3	120.4	11.90	110.3	67.4	83.37	55.98	22.15	17.18
NDR-3112	144.7	121.8	22.90	125.5	87.2	86.73	60.91	18.85	16.23
NDR-2065	135.7	126.9	8.80	116.7	82.8	85.70	65.24	22.95	18.75
NDR-359	124.5	114.2	10.30	101.6	63.7	81.60	55.77	21.55	15.85
NDR-8002	151.4	137.3	14.10	128.5	87.9	84.87	64.02	20.85	16.90
Swarna Sub-I	138.7	121.9	16.80	118.3	76.8	85.29	63.00	20.15	15.45
BPT-5204	162.3	135.7	26.60	123.5	78.6	76.09	57.92	18.35	16.75
MTU-7029	166.5	148.7	17.80	133.6	88.2	80.24	71.17	19.50	18.60
Sarjoo-52	171.9	154.3	17.60	152.1	93.7	88.48	60.72	19.90	17.75
Sugandha-5	148.3	131.2	17.10	124.7	80.4	84.08	61.28	20.10	20.15
SEm±	1.89	1.08	0.57	1.59	2.15	0.72	0.90	0.65	0.24
CD at 5%	5.71	3.23	1.69	4.71	6.44	2.14	2.63	1.88	0.71

Table 2 : Effect of sheath rot disease on qualitative losses

Variety	No. of discoloured grains		Discolouration %		Germination %		Seedling length (cm)		Vigour Index	
	Healthy	Infected	Healthy	Infected	Healthy	Infected	Healthy	Infected	Healthy	Infected
Susk Samrat	11.3	33.5	9.07	28.33	90	47	16	12	1440	564
NDR-3112	17.1	40.7	11.81	33.41	82	39	15.5	10.5	1240	409.5
NDR-2065	15.8	38.31	12.34	30.18	92	49	15	10.5	1380	514.5
NDR-359	19.6	42.1	14.81	33.95	87	46	13.5	11.5	1174.5	529
NDR-8002	18.8	38.9	12.41	29.33	85	45	14	11	1190	528
Swarna Sub-I	17.7	46.8	8.43	38.39	83	44	15	12.5	1245	550
BPT-5204	25.3	54.8	10.32	40.38	80	37	14.5	11.5	1160	425.5
MTU-7029	21.7	48.6	13.03	32.68	81	40	14	13	1134	500
Sarjoo-52	23.4	48.5	13.61	31.43	82	42	17	14	1394	588
Sugandha-5	21.2	53.3	14.29	40.62	83	43	18	15.5	1494	666.5
SEm±	0.42	0.46	0.30	2.23	0.67	0.83	0.42	0.33	35.67	15.10
CD at 5%	1.26	1.35	0.89	6.67	1.92	2.54	1.23	1.02	104.06	45.23

Table 3 : Comparison of healthy and infected grain against Biochemical properties

Variety	Total sugar (mg/g)		Reducing sugar(mg/g)		Non-reducing sugar (mg/g)		Phenolic content (mg/g)	
	Healthy	Infected	healthy	Infected	Healthy	Infected	Healthy	Infected
Susk Samrat	5.2	4.4	2.17	1.78	3.03	2.62	0.42	0.31
NDR-3112	5.3	4.6	2.20	1.84	3.10	2.76	0.45	0.35
NDR-2065	5.1	4.5	2.16	1.81	2.94	2.69	0.43	0.34
NDR-359	4.9	3.5	2.15	1.66	2.75	1.84	0.39	0.28
NDR-8002	5.5	4.3	2.22	1.85	3.28	2.45	0.43	0.34
Swarna Sub-I	5.0	4.8	2.23	1.80	2.77	3.00	0.40	0.29
BPT-5204	5.1	4.2	1.96	1.75	3.14	2.45	0.41	0.32
MTU-7029	5.5	4.7	2.27	1.87	3.23	2.83	0.48	0.37
Sarjoo-52	5.7	4.8	2.30	1.91	3.40	2.89	0.49	0.38
Sugandha-5	5.5	4.2	2.19	1.86	3.31	2.34	0.46	0.35
SEm±	0.071	0.071	0.034	0.031	0.043	0.040	0.007	0.004
CD at 5%	0.212	0.210	0.102	0.091	0.126	0.120	0.020	0.013

52 and Susk Samrat (Table-1). Similar trend was observed in case of unfilled grains also earlier Rajan and Nair (1978).

Grain filling percentage

The grain filling percentage healthy ear head was observed maximum grain filling percentage (88.52) in variety Susk Samrat followed by (88.48) in variety MTU-7029 were recorded while minimum grain filled percentage was recorded (76.09) in variety BPT-5204 significant variance were observed regarding the minimum and maximum grain filling percentage in case of Susk Samrat and BPT-5204.

The grain filling percentage infected ear head was observed maximum grain filling percentage (71.17) in variety MTU-7029 followed by (65.24) in variety NDR-2065 were recorded while minimum grain filled percentage was recorded (57.92) in variety BPT-5204 significant variance were observed regarding the minimum and maximum grain filling percentage in case of MTU-7029 and BPT-5204 (Table-1). Similarly was emphasized by Raina and Singh (1980) and Vidhyasekaran and Lewin (1987).

1000 grains weight (g)

The 1000 grains weight (g) healthy ear head was observed maximum 1000 grains weight (22.95) in variety NDR-2065 followed by (22.15) in variety Susk Samrat were recorded while minimum 1000 grains weight was recorded (18.35) in variety BPT-5204 significant variance were observed regarding the minimum and maximum 1000 grains weight in case of NDR-2065 and BPT-5204.

The 1000 grains weight (g) infected ear head was observed maximum 1000 grains weight (20.15) in variety Sugandha-5 followed by (18.75) in variety NDR-2065 were recorded while minimum grain filled percentage was recorded (15.85) in variety NDR-359 significant variance were observed regarding the minimum and maximum number of grain filling percentage in case of Sugandha-5 and NDR-359 (Table-1). Finding of several reports are in agreement with the present findings as they had reported by several researchers Raju and Singh (1981), Reddy (1991), Das and Naik (1992), Venkateswarlu and Chauhan (2005), Chellappan *et al.* (2010) and Prasad *et al.* (2011).

Qualitative losses
Number of discoloured grains/panicle

The number of discoloured grains/panicle healthy ear head was observed maximum number of discoloured grains/panicle (25.3) in variety BPT-5204 followed by (23.4) in variety Sarjoo-52 were recorded while minimum number of discoloured grains/panicle was recorded (11.3) in variety Susk samrat significant variance were observed regarding the minimum and maximum number of discoloured grains/panicle in case of BPT-5204 and Susk Samrat.

The number of discoloured grains/panicle of infected ear head was observed maximum number of discoloured grains/panicle (54.8) in variety BPT-5204 followed by (53.3) in variety Sugandha-5 were recorded while minimum number of discoloured grains/panicle was recorded (33.5) in variety Susk Samrat significant variance were observed regarding the minimum and maximum number of number of discoloued grains/panicle in case of BPT-5204 and Susk Samrat (Table-2). Similar work earlier reported Rajan and Nair (1978) and Thrimurty (1986).

Discolouration percentage

The discolouration percentage of healthy ear head was observed maximum discolouration percent (14.81) in variety NDR-359 followed by (14.29) in variety Sugandha-5 were recorded while minimum discolouration percent was recorded (9.07) in variety Susk Sarmat significant variance were observed regarding the minimum and maximum discolouration percentage in case of NDR-359 Susk Samrat.

The discolouration percentage of infected ear head was observed maximum discolouration percent (40.62) in variety Sugandha-5 followed by (40.38) in variety BPT-5204 were recorded while minimum discolouration percent was recorded (28.33) in variety Susk Samrat significant variance were observed regarding the minimum and maximum discolouratin percentage in case of Sugandha-5 and Susk Samrat (Table-2). Same observations was reported by many researchers Raina and Singh (1980) and Thrimurty (1986).

Germination percentage

The germination percentage of healthy ear head was observed maximum germination percentage (92) in variety NDR-3112 followed by (90) in variety Susk Samrat were recorded while minimum germination percentage was recorded (80) in variety BPT-5204 significant variance were observed regarding the minimum and maximum discolouration percentage in case of NDR-3112 and BPT-5204.

The percentage of infected ear head was observed maximum germination percentage (49) in variety NDR-2065 followed by (47) in variety Susk Samrat were recorded while minimum germination percent was recorded (37) in variety BPT-5204 significant variance were observed regarding the minimum

and maximum germination percentage in case of NDR-2065 and BPT-5204 (Table-2). Similar work reported by Prasad *et al.* (2011).

Seedling length (cm)

The seedling length (cm) of healthy ear head was observed maximum seedling length (18) in variety Sugandha-5 followed by (17) in variety Sarjoo-52 were recorded while minimum seedling length was recorded (13.5) in variety NDR-359 significant variance were observed regarding the minimum and maximum discoloration percentage in case of Sugandha-5 and NDR-359.

The seedling length of infected ear head was observed maximum seedling length (15.5) in variety Sugandha-5 followed by (14.0) in variety Sarjoo-52 were recorded while minimum seedling length was recorded (10.5) in variety NDR-3112 and NDR-2065 significant variance were observed regarding the minimum and maximum seedling length in case of Sugandha-5 and NDR-3112, NDR-2065 (Table-2). Similar trends was presented by Prasad *et al.* (2011) and Raju and Singh (1981).

Vigour index

The vigour index of healthy ear head was observed maximum vigour index (1494) in variety Sugandha-5 followed by (1440) in variety Susk Samrat were recorded while minimum vigour index was recorded (1134) in variety MTU-7029 significant variance were observed regarding the minimum and maximum vigour index in case of Sugandha-5 and MTU-7029**.**

The vigour index of infected ear head was observed maximum vigour index (666.5) in variety Sugandha-5 followed by (588) in variety Sarjoo-52 were recorded while minimum vigour index was recorded (409.5) in variety NDR-3112 and NDR-2065 significant variance were observed regarding the minimum and maximum seedling length in case of Sugandha-5 and NDR-3112 (Table-2). Similar findings was reported by several workers Reddy *el al.* (2000) and Kumar *et al.* (1992).

Biochemical changes in seeds due to sheath rot

Consequent upon infection of sheath rot disease of rice the total sugar, reducing sugar as well as non-reducing sugar decreases. Likewise the Phenolic content was increase due to the infection in healthy seeds presented in (table-3). It was total sugar in healthy seeds BPT-5204 (5.1) followed by NDR-359 (4.9), in infected seeds BPT-5204- (4.2) followed by NDR-359 (3.5). Reducing sugar in healthy seeds NDR-359 (2.15) followed by BPT-5204 (1.9), in infected seeds BPT-5204- (1.75) followed by NDR-359 (1.66). Non-sugar in healthy seeds BPT-5204 (3.14) followed by NDR-359 (2.75), in infected seeds BPT-5204- (2.45) followed by NDR-359 (1.84). The fact that sheath rot decreases the total sugar, reducing sugar and nan-reducing sugar has been recorded by various workers Bilgrami *et al.* (1979) and Reddy *et al.* (2000).

Phenol content

Phenol content in healthy seeds BPT-5204 (0.32) followed by NDR-359 (0.28), in infected seeds BPT-5204- (0.41) followed by NDR-359 (0.39) represented in table-3. Present results are in accordance with those of earlier worker Prasad *et al* (2011).

CONCLUSION

Finally, it is concluded that the infection of sheath rot disease of rice, the reduction in total number of grains/panicle, number of filled grains/panicle, 1000 grains weight, number of discoloured grains/ panicle, germination %, seedling length and vigour index were decreased. Further, the total sugar, reducing sugar as well as non-reducing sugar also decreased. Likewise, the phenol content was increased due to the infection as compared to healthy seeds.

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