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Effect of various sources of nutrients on growth of *Sarocladium oryzae* (Sawada) Gams and Hawksworth causing sheath rot of rice (*Oryza sativa* L.)

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Abstract
Rice is an important cereal crop and is attacked by various fungal pathogens. The intensity of sheath rot disease depends upon application of various levels of major nutrients like nitrogen, potash etc in the plants. The current study was conducted in the Dept. of Plant Pathology, College of Agriculture, O.U.A.T, Bhubaneswar, Odisha. Out of ten nitrogen sources ammonium ferrous sulphate supported maximum growth (415.3mg) of the causal pathogen followed by potassium nitrate (302.0mg). Among eight carbon sources starch supported significant growth of *S. oryzae* (491.0mg) followed by L-aspergine (263.0mg). Potassium dihydrogen phosphate recorded highest dry mycelial growth (1552.3mg) of the causal pathogen closely followed by di-potassium hydrogen phosphate (1475.7mg). Magnesium sulphate recorded highest mycelial dry matter (1385.7mg) and ammonium persulphate was the next best source of sulphur for the causal pathogen (400.7mg).

Keywords: Nutrients, mycelial growth, *S. oryzae*, sheath rot

Introduction
Rice (*Oryza sativa* L.) is an important food grain in India. Rice is grown widely across the nation in more than 20 states and in an area of over 400 lakh hectares. Major rice growing states in India are West Bengal, Bihar, Madhya Pradesh, Punjab, Chhatisgarh, Odisha, Assam, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala and Uttar Pradesh. Rice is affected by many biotic and abiotic stresses. Among them blast, sheath blight, sheath rot, brown spot and bacterial blight are the most important for this state, causing huge economic yield losses. *Sarocladium oryzae* causing sheath rot of rice is imposing threat in most parts of rice growing area of the country. Sawada (1922) [9] first described this disease from Taiwan and the causal organism was first named as *Acrocylindrium oryzae* Sawada, which was later renamed as *Sarocladium oryzae* by Gams and Hawksworth in 1975. In India, Agnihothrudu (1973) [1] recorded this disease for the first time and later several workers reported the disease from different parts of the country (Naik and Roy, 1975; Thrimurty *et al*., 1980) [7, 8]. Bigirimana *et al.* (2015) [4] reported 85% yield loss of rice due to sheath rot. Sheath rot disease has been spreading among the newly released varieties (Shamsi *et al.* 2010) [11]. The intensity of sheath rot disease depends upon application of various levels of major nutrients like nitrogen and potash in the plants. Information on the nutritional requirements for the enhancement of growth of *S. oryzae* is scanty. The current study was intended to evaluate various sources of nutrients like nitrogrn, potash etc on the growth of *Sarocladium oryzae* and the study was conducted in the Dept. of Plant Pathology, College of Agriculture, O.U.A.T, Bhubaneswar, Odisha.

Materials and Methods
Effect of different nitrogen sources on the growth of *S. oryzae*
Czapek's dox broth was used as the basal medium for this study. Ten nitrogen sources namely, ammonium carbonate, L-asparagine, sodium nitrate, sodium nitrite, potassium nitrate, ammonium oxalate, glycine, ammonium ferrous sulphate, urea and ammonium persulphate were tested for the utilization by causal organism *S. oryzae*. Hundred ml of Czapek's dox broth was transferred into 250 ml conical flask and required amount of each nitrogen source was added separately into the basal medium in place of sodium nitrate and one control was maintained without any nitrogen source. The quantity of nitrogen compound used was determined on the basis of their molecular weight so as to provide an equivalent amount of nitrogen as that of Sodium nitrate present in the base medium.

It was sterilized and allowed to cool. Streptomycin was added to avoid any bacterial contamination. Five mm of fungal disc was cut by sterilized cork borer and put into the conical flask containing broth aseptically. Three replications were maintained for each treatment. After 12 days of inoculation the mycelial mat was filtered through previously weighed filter papers separately. These growths along with the filter paper were oven dried at constant 60 ^{0}C till getting constant weight. Then the dry weight of the filtered mats was taken using a digital balance.

Effect of various carbon sources on the growth of *S. oryzae*
Eight different carbon sources *viz.*, L-asparagine, dextrose, glucose, maltose, manitol, sucrose, starch and glycine were tested for the growth of test pathogen. Basal medium Czapek's dox broth was prepared and 100 ml broth was poured into the 250 ml conical flask. Required amount of each carbon source was added in the place of sucrose and one control was made without any carbon source and methods followed as described above. The results were analyzed statistically.

Effect of different sources of potash on the growth of *S. oryzae*
Required amount of different potash sources namely, potassium dihydrogen phosphate, potassium chloride, potassium nitrate, potassium sulphate, potassium dichromate, potassium hydroxide, di-potassium hydrogen phosphate and potassium ferrocyanide trihydrate were taken and added into the each 250 ml conical flask containing 100 ml Czapek's dox broth in the place of potassium dihydrogen phosphate. One control was maintained without any potash source and methods followed as described above. The results were analyzed statistically.

Effect of different sources of sulphur on the growth of *S. oryzae*
Six different sulphur sources like magnesium sulphate, copper sulphate, ammonium ferrous sulphate, zinc sulphate, ferrous sulphate and ammonium persulphate were tested for the utilization of *S. oryzae*. Czapek's dox broth was taken as basal medium and each compound was incorporated separately into 250 ml conical flask containing 100 ml broth in the place of magnesium sulphate. One control was maintained without any sulphur source and the results were analyzed statistically.

Results and Discussion

Effect of different nitrogen sources on the growth of *S. oryzae*
Ten nitrogen sources were tested for the growth of *S. oryzae*. Out of them ammonium ferrous sulphate supported maximum growth (415.3mg) of the causal pathogen followed by potassium nitrate (302.0mg). Sodium nitrite retarded the growth of *S. oryzae* and there was 100% reduction of mycelial growth. The causal pathogen was produced 37.0mg dry mycelial mat without any nitrogen. KNO_3 and $NaNO_3$ served as best source of nitrogen (Chien and Thseng, 1981and Agarwal and Ganguli, 1960) [3]. In the present study potassium nitrate and sodium nitrate produced 302.0mg and 201.0 mg dry mycelia respectively. The causal pathogen flourished in a similar way such as ammonium carbonates, ammonium oxalate, glycine and urea were added as nitrogen sources (Table-1, Fig-1).

Effect of various carbon sources on the growth of *S. oryzae*
Carbon also played important role on the growth of the causal pathogen. Out of eight carbon sources starch supported significant growth of *S. oryzae* (491.0mg) followed L-aspergine (263.0mg). Lowest growth (41.3mg) was observed in the absence of carbon. Dextrose, glucose, sucrose and glycine supported for the growth of the causal pathogen in similar way with no such differences. Mohan and Subramanian (1978) [6] had got similar result of best growth of *S. oryzae* in starch and sucrose. Aspergine and sucrose amended medium proved best for *S. oryzae* (Sharma, 2009) [10]. In the current study also L-aspergine recorded better yield of mycelial mat next to starch (Table-2, Fig-2).

Growth behavior of different potash source on the dry matter production of *S. oryzae*
Different sources of potash also influenced significantly for the growth of *S. oryzae.* Potash from potassium dihydrogen phosphate recorded highest dry mycelial growth (1552.3mg) of the causal pathogen closely followed by di-potassium hydrogen phosphate (1475.7mg). Potassium nitrate, Potassium sulphate and potassium ferrocynide trihydrate recorded similar growth pattern for the growth of *S. oryzae*. Alagarsamy (1989) [2] also reported varied response of potash for the growth of *S. oryzae*. In the current study lowest growth was found in the absence of potash (105.0mg) (Table-3, Fig-3).

Growth behavior of *S. oryzae* in different source of sulphur
Significant varied responses were observed for the mycelial growth of *S. oryzae* by different sources of sulphur. Magnesium sulphate recorded highest mycelial dry matter (1385.7mg). Ammonium persulphate was the next best source of sulphur for the causal pathogen (400.7mg) much lower than magnesium sulphate. Agarwal and Ganguli (1960) [3] reported magnesium sulphate as the best source of growth for other fungus like *Pestalotiopsis versicolor*. In the current study, copper sulphate and zinc sulphate completely checked the growth of *S. oryzae* and only 88.0 mg dry mycelial mat was recorded without any sulphur. Ferrous sulphate was also found to have some fungicidal activity and it reduced the growth of *S. oryzae* (18.0mg) less than control i.e without any sulphur. The result revealed that magnesium sulphate had some good effect so that the pathogen could utilize the sulphur to increase its mycelial dry matter (Table-4, Fig-4)

Table 1: Effect of different nitrogen sources on the growth of *S. oryzae*

S. No	Nitrogen source	Mean dry mycelial weight (mg)
1	Ammonium carbonate	138.0 (11.7)
2	L- Aspergine	152.0 (12.34)
3	Sodium nitrate	201.3 (14.1)
4	Sodium nitrite	0.00 (0.71)
5	Potassium nitrate	302.00 (17.3)
6	Ammonium oxalate	141.3 (11.9)
7	Glycine	135.3 (11.7)
8	Ammonium ferrous sulphate	415.3 (20.40)
9	Urea	126.7 (11.2)
10	Ammonium persulphate	42.0 (6.50)
11	Control (without nitrogen)	37.0 (6.10)
	SE(m)$^{\pm}$	0.7
	CD @ 5%	2.1

Figures in the parenthesis indicate corresponding √[x+0.5] transformed value

Table 2: Effect of carbon sources on the growth of *S. oryzae*

S. No	Carbon source	Mean dry mycelia weight (mg)
1	L- Aspergine	263.0
2	Dextrose	134.0
3	Glucose	113.3
4	Maltose	223.3
5	Manitol	204.0
6	Sucrose	147.7
7	Starch	491.0
8	Glycine	121.7
9	Control (without carbon)	41.3
	SE(m)±	16.2
	CD @ 5%	48.4

Table 3: Effect of different sources of potash on the growth of *S. oryzae*

S. No	Potash source	Mean dry mycelia weight (mg)*
1	Potassium dihydrogen phosphate	1552.3 (39.4)
2	Potassium chloride	293.0 (17.1)
3	Potassium nitrate	157.7 (12.6)
4	Potassium sulphate	177.7 (13.3)
5	Potassium dichromate	0.00 (0.71)
6	Potassium hydroxide	482.3 (22.0)
7	di-potassium hydrogen phosphate	1475.7 (38.4)
8	Potassium ferrocyanide trihydrate	174.0 (13.2)
9	Control (without potassium)	105.0 (10.3)
	SE(m)±	0.5
	CD @ 5%	1.4

Figures in the parenthesis indicate corresponding √[x+0.5] transformed value

Table 4: Effect of different sources of sulphur on the growth of *S. oryzae*

S. No	Sulphur sources	Mean dry mycelia weight (mg)
1	Magnesium sulphate	1385.7 (37.2)
2	Copper sulphate	0.0 (0.71)
3	Ammonium ferrous sulphate	116.0 (10.8)
4	Zinc sulphate	0.0 (0.71)
5	Ferrous sulphate	18.0 (4.3)
6	Ammonium persulphate	400.7 (20.0)
7	Control (without sulphur)	88.0 (9.4)
	SE(m)±	0.2
	CD @ 5%	0.7
Figures in the parenthesis indicate corresponding √[x+0.5] transformed value		

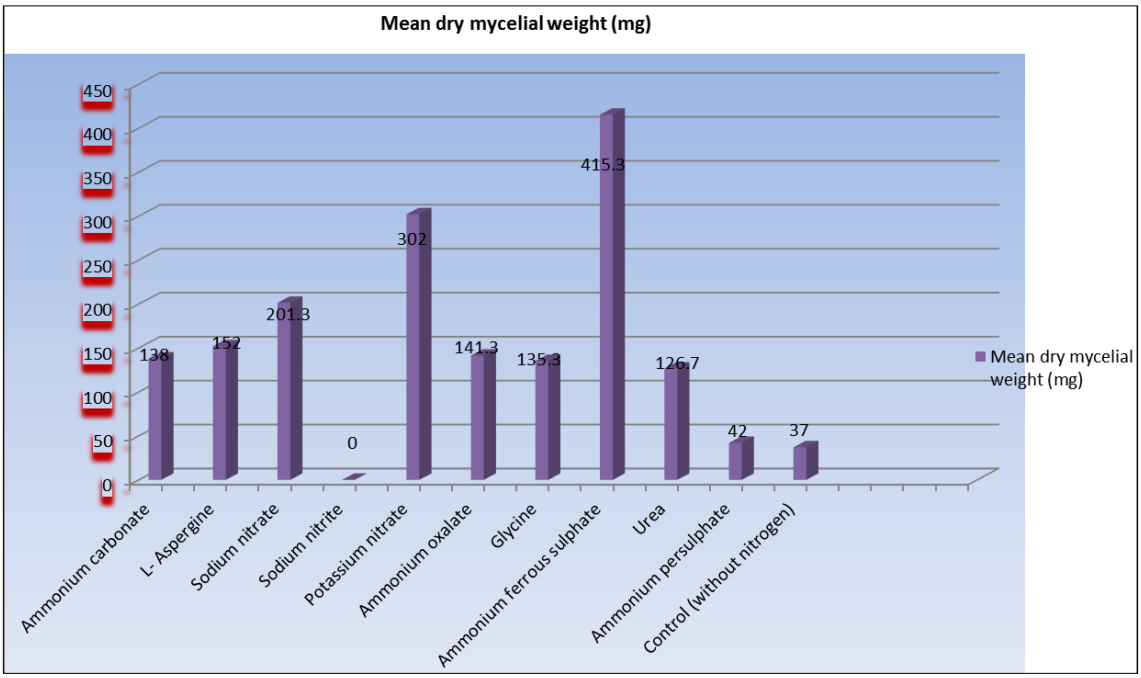

Fig 1: Effect of different nitrogen sources on the growth of *S. oryzae*

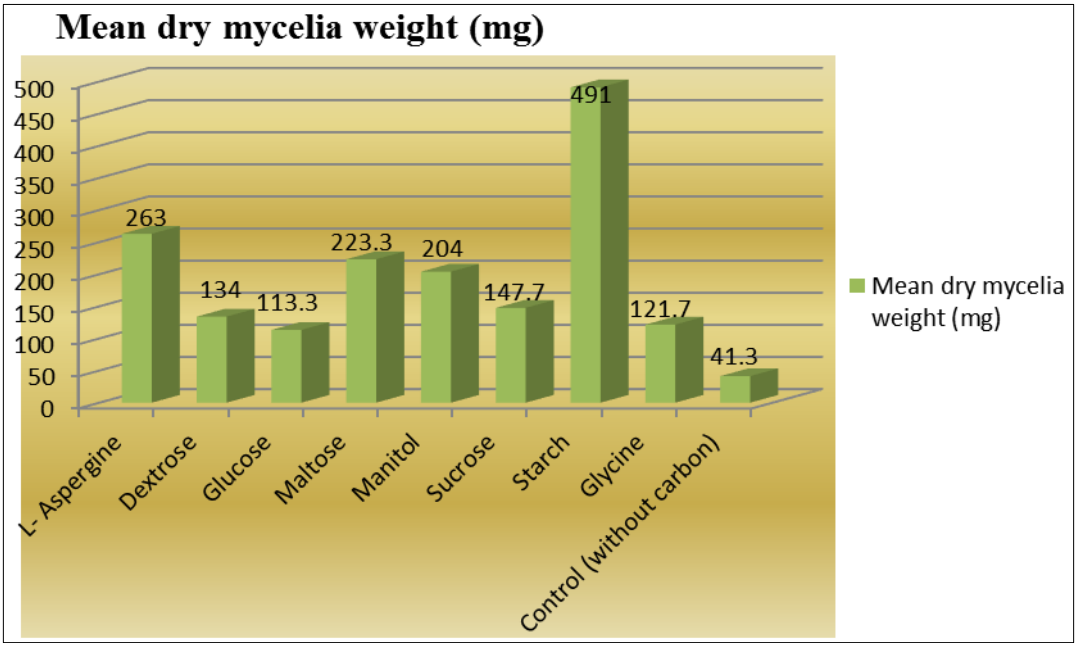

Fig 2: Effect of different sources of carbon on the growth of *S. oryzae*

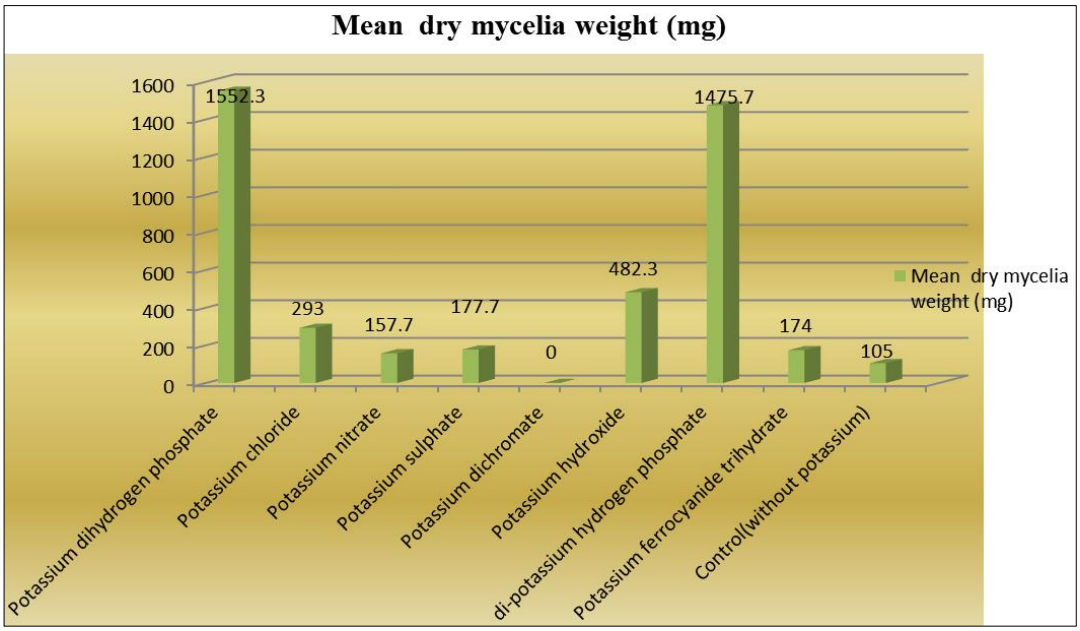

Fig 3: Effect of different potash sources on the growth of *S. oryzae*

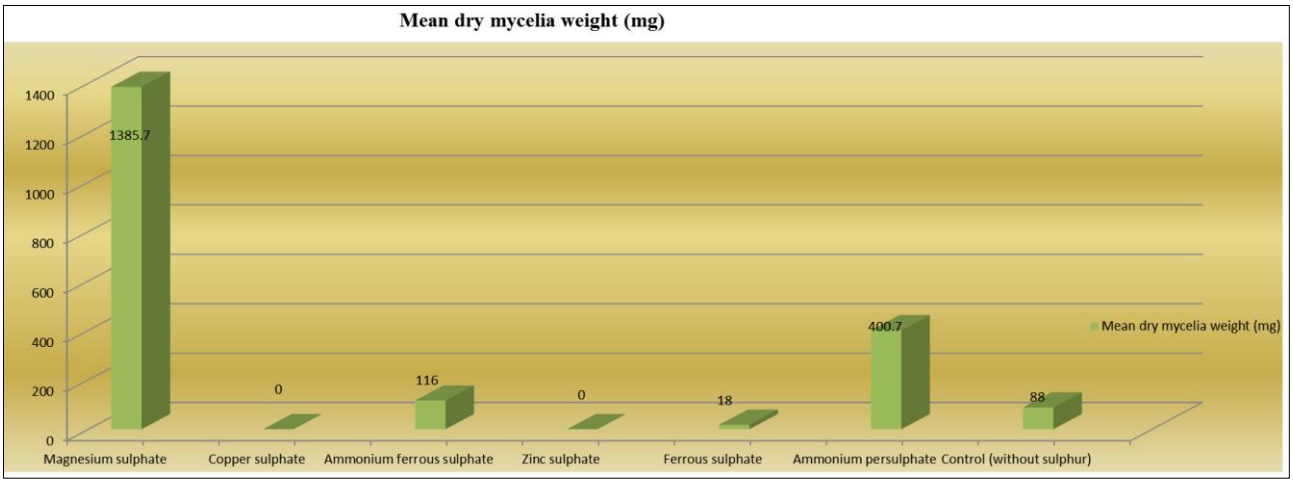

Fig 4: Effect of different sulphur sources on the growth of *S. oryzae*

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