AN APPROACH TOWARDS CONTROL OF BLAST BY FOLIAR APPLICATION OF SEAWEED CONCENTRATE

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ABSTRACT

The efficacy of aqueous concentrates of *Padina pavonia*, *Acanthophora spicifera* and *Ulva lactuca* as foliar spray on reducing the severity of fungal blast of rice caused by *Pyricularia oryzae* was investigated. The results indicated that all the seaweed concentrates significantly reduced the severity of the disease. Among the seaweeds *Acanthophora spicifera* concentrate was found to have more constrained over blast in rice on the basis of infection index. Present study also revealed that the peroxidase activity and phenylalanine ammonia – lyase activity were at higher level than the control (without any application). Seaweed concentrates of all the three species enhanced sugar, starch, protein level in 60th day where as decreased in 80th day. All the parameters were also analysed with foliar application of Bavistin, a common fungicide and the results were compared.

Key words: Seaweed concentrate, blast, rice.

INTRODUCTION

India is one leading producer of rice in Asia (Tony Cisse, 2005). Rice crop has been under cultivation from time immemorial, being grown under varying climatic in different parts of the country. It is widely affected by quite a number of diseases caused by fungi, bacteria, viruses and mycoplasma that results in yield losses (Ou, 1985).

Among the fungal diseases, blast incited by *Pyricularia oryzae* is a major disease occurring in almost all the rice-growing areas of the world and is the most destructive fungal disease of rice causing yield loss up to 90 percent (Mehrotra, 1998) despite decades of research towards its management. The management of blast disease is done by using fungicides, growing resistant varieties, application of organic amendments, balanced nutrition, biological agents and resistance inducing chemicals. The use of chemical fungicides resulted in environmental pollution and ill health to biotic community as a whole. This necessitates developing natural product as alternative to synthetic fungicides to control the blast disease in rice of economic importance. The present investigation was carried out to light the role of seaweeds in the control of blast disease of rice.

MATERIALS AND METHODS

Collection of Seaweeds:

Seaweeds collected from Idiathakari coast of Gulf of Mannar, Tamil Nadu, India from October to January 2008. Dominated species of algae representing the classes Chlorophyceae (*Ulva lactuca*), Phaeophyceae (*Padina pavonia*) and Rhodophyceae (*Acanthophora spicifera*) were chosen for present investigation.

` After hand picking, the seaweeds were washed initially with seawater. The epiphytes and other extraneous matters were removed and washed with fresh water (4-5 times). The seaweeds were dried under shade at 30 to 35^{0}c and 65-70% relative humidity. These air dried seaweeds were powdered in an electrical miller, then sieved and stored.

Preparation of aqueous extract

100g of powdered seaweed was mixed with distilled water in the ratio of 1:10 ratio and autoclaved at 150lb pressure for 1hour. The extracts were filtered immediately through a muslin cloth. All the extracts were measured, labeled and stored in bottles which were kept in a refrigerator. The extracts thus obtained were taken as 100% seaweed concentrate (SWC). SWC of 1% was prepared with distilled water and used for the present study.

Experimental Study: 30s day old seedlings of paddy variety ADT 43 were barlapped from the field at Kuppanapuran, Thoothukudi district, Tamilnadu and planted in pots containing the same soil to preserve its natural growth condition.

After the seedlings have been acclimatized they were treated with reconstituted SWC (1%) during the morning hours as foliar spray. Bavistin (0.1%) was also similarly administered for comparative analysis. Plants retained without any application served as control and enough duplicates were maintained under field conditions.

Analysis:

Samples from each treatment were randomly drawn 20, 60, 80 days after treatment. Numbers of lesions were counted at least in 10 replicates.

Leaves were used to estimate sugar, starch, protein, total nitrogen and phosphorus as per the standard procedures. Peroxidase (Hammerschmidt *et al*., 1982) and Phenylalanine Ammonia - Lyase (Zucker, 1965) activities were also determined. Triplicate samples were used and the mean values with standard deviation were presented. Yield potential was recorded on 90th day based on the number of barren and filled seeds.

RESULTS AND DISCUSSION

The number of lesions shown in fig. (1) clearly indicated that extract of *A. spicifera* was highly antagonistic towards *Pyricularia oryzae*. Bavistin application controlled the disease more effectively than all the seaweed concentrates after 20 days of treatment. However as the treatment continued the antagonistic effect of SWC of *A. spicifera* was significantly more than bavistin (fig.1).

Effect of SWC application on sugar, starch and protein was presented in tables (1, 2, and 4). The results indicated that the treatments had no significant changes during the 20th day assay. However on the 80th day there was vast decrease in sugar and starch in the control than treated where as protein content was not much altered. In control amount of nitrogen remained more or less constant through out the period of study. In contrast, nitrogen was decreased with bavistin and SWC treatment on the 60th and **80th** day (Table 5). Amount of phosphorus was unaltered by these treatments throughout however in control it get decreased with days (Table 3).

Peroxidase activity was same in all the plants except the one received SWC of A. *spicifera* on the 20th day after treatment. Further, the enzyme activity was decreased on 60th and 80th day in the control, and it was enhanced with SWC treatment. The enzyme activity was found to be increased at the same rate both in bavistin and *A. spicifera* treated plants, however others showed little variation (Table 6). Phenylalanine ammonia - lyase activity also decreased with age in control. The activity increased with age more in plants applied with *Acanthophora spicifera* extract, thus establishing its antagonistic and controlling effect on blast disease (Table 7).

Yield potential is established based on the number of filled grains, treated plants produced more filled grains where as it was only 62 in the control (Fig 2).

Table 1: Effect of foliar application of swc on total sugar (mg/g fresh weight) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	9.0±0.1	8.0±0.1	7.6±0.04
Bavistin	9.6±0.08	10±0.05	9.2±0.05
Ulva lactuca	9.4±0.06	10±0.05	9±0.05
Acanthophora spicifera	10.5±0.05	10.9±0.07	10±0.03
Padina pavonia	9.4±0.05	10.5±0.08	9±0.08

Table 2: Effect of foliar application of swc on starch (mg/g dry weight) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	7±0.02	6.2±0.1	6.2±0.1
Bavistin	7.8±0.06	7.8±0.04	7.6±0.01
Ulva lactuca	8±0.04	8±0.02	7.9±0.02
Acanthophora spicifera	8.2±0.06	8.4±0.06	8.1±0.06
Padina pavonia	7.3±0.05	7.4±0.03	7.1±0.02

Table 3: Effect of foliar application of swc on phosphorus (mg/g dry weight) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	0.26±0.07	0.22±0.03	0.20±0.02
Bavistin	0.28±0.09	0.28±0.09	0.30±0.02
Ulva lactuca	0.28±0	0.29±0.01	0.29±0.01
Acanthophora spicifera	0.29±0.02	0.30±0.02	0.32±0.03
Padina pavonia	0.28±0	0.29±0.01	0.29±0.02

Table 4: Effect of foliar application of swc on protein (mg/g fresh weight) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	6.8±0.04	6.6±0.05	6.4±0.02
Bavistin	6.9±0.06	7.0±0.05	6.8±0.03
Ulva lactuca	6.8±0.04	7±0.02	6.7±0.05
Acanthophora spicifera	7.2±0.01	7.5±0.02	7.3±0.04
Padina pavonia	6.7±0.02	6.9±0.02	6.6±0.02

Table 5: Effect of foliar application of swc on nitrogen (mg/g dry weight) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	5.8±0.02	6.2±0.02	6.2±0.03
Bavistin	8.2±0.04	7.2±0.03	6.1±0.02
Ulva lactuca	8.2±0.03	7.3±0.05	6.1±0.1
Acanthophora spicifera	7.2±0.04	7.2±0.03	5.9±0.2
Padina pavonia	8.2±0.03	7.4±0.07	6.1±0.2

Table 6: Effect of foliar application of swc on peroxidase enzyme activity (OD_{470}/g^{-min}) content of rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	0.30±0.04	0.27±0.01	0.24±0.02
Bavistin	0.30±0.01	0.48±0.03	0.49±0.01
Ulva lactuca	0.30±0.02	0.30±0.02	0.32±0.01
Acanthophora spicifera	0.46±0.01	0.52±0.03	0.54±0.01
Padina pavonia	0.25±0.06	0.27±0.02	0.30±0.06

Table 7: Effect of foliar application of swc on phenylalanine ammonia- lyase enzyme activity in rice leaf

Treatment	After 20 Days	After 60 Days	After 80 Days
Control	0.20±0.01	0.125±0.01	0.156±0.01
Bavistin	0.80±0.01	0.93±0	0.95±0
Ulva lactuca	0.95±0.02	0.96±0.03	0.97±0.01
Acanthophora spicifera	0.80±0	0.98±0.07	0.99±0.02
Padina pavonia	0.92±0	0.96±0.01	0.98±0.09

Activity is expressed as µmol transcinnamic acid g.fresh weight $^{-1}$min^{-1}.

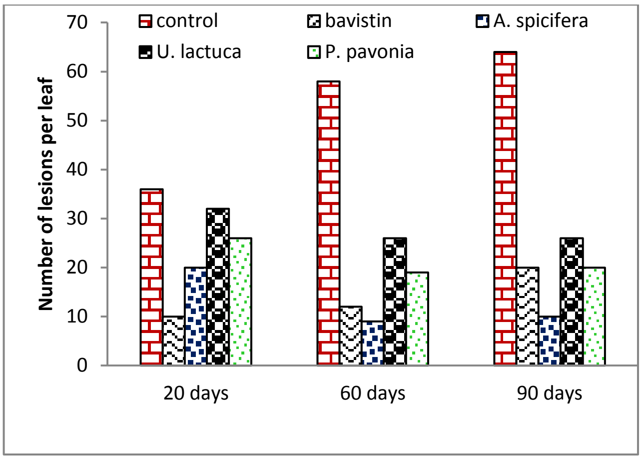


Fig 1: Effect of foliar application of SWC on number of lesions in rice leaves

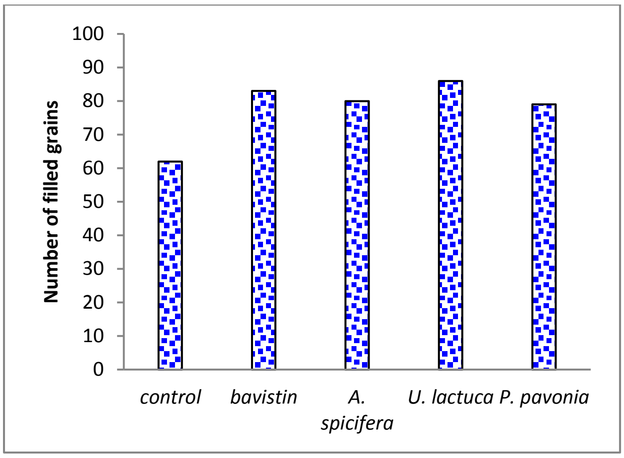
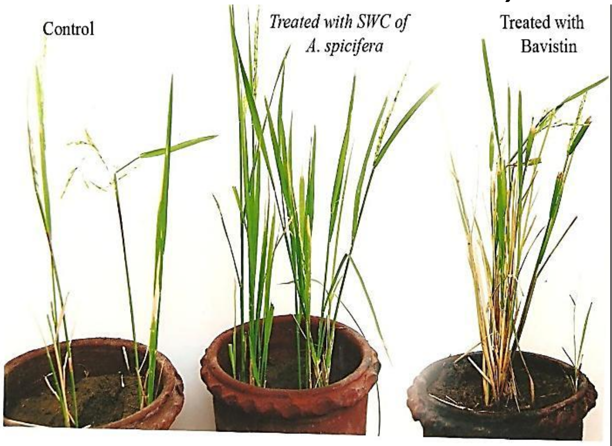


Fig 2: Effect of foliar application of swc on yield parameter

Plate 1: Effect of SWC in tiller formation in *Oryza sativa*



Marine algae can serve as an important source of plant defense elicitors (Cluzet *et al.,* 2004, Antonios Zambounis *et al.,* 2012). *A* variety of polysaccharides carrageenans, alginates, phenols elicit multiple defense responses in various plants (Kobayashi *et al.,* 1993, Klarzynski *et al.,* 2003, James S. Craigie, 2011). Foliar sprays of *Ascophyllum nodosum* extract reduced *Phytophthora capsici* infection in capsicum and *Plasmodiophora viticola* in grape. (Lizzy *et al.,* 1998). Soil application of SWC inhibits *Pythium ultimum* that causes damping-off disease of seedlings (Dixon and Walsh 2002). A red seaweed *Solieria robusta* used as soil amendment showed better suppressive effect on root rotting fungus *Fusarium solani* than Topsin-M, a fungicide in soya bean (Viqarsultana *et al.,* 2011).SWC rich in polyphenols have bactericidal properties (Zhang *et al.,* 2006). Thus the reduced incidence of blast disease in rice could be attributed to the phenolic compounds, agar, carrageenan, sulfated fucans predominantly present in these sea weeds. It was also found that there was a decrease in sugar, starch, protein level on 80th day. This may perhaps be due to seed filling stage during which nutrients may be channelized from leaves to seeds. Activity of certain defense – related enzymes, including peroxidase, polyphenyl oxidase, phenylalanine ammonia- lyase, chitinase and β- 1,3- glucanase were significantly increased in plants treated with seaweed (Jayaraj *et al.,* 2008, Manoj Kumar Solanki *et al*., 2012) is in accordance with our findings.

The data provide evidence for the close relationship of reduction in disease incidence with that of enhanced peroxidase and phenyl alanine ammonia lyase activity. Phenyl alanine ammonia lyase is the enzyme of phenyl propanoid metabolism in higher plants and it has been played an important role in the accumulation of phenolics, phytoalexin and lignin which is responsible for disease resistance (Vidyasekaran 1988). Peroxidase plays an important role in the biosynthesis of plant cell walls. Lignification and wall thickening are well known defense responses to pathogens particularly to fungi. Another possible role of peroxidase is the oxidative cross linking of pre existing hydroxy proline structural proteins in the cell wall making it more resistant to degradation by microbial enzyme(Bradely *et al.,* 1992) . However, the additional nutrients such as minerals, amino acids, alginic acid, simple and complex carbohydrates, growth stimulators in SWC also have played a conspicuous role in the enhancement of growth (Plate 1) that also would have added resistance.

The present findings explict that SWC of *Acanthophora spicifera* could be effectively used as a fungicide, comparable with bavistin as an environment friendly alternative.

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