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Management of Rice Sheath Blight by using plant activator and silicon based nutrient

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Abstract: **The paper deals with the investigate about resistance inducing chemicals and silicon based nutrients for the successful sustainable management of rice sheath blight. Among the various treatments sheath blight disease incidence was effectively controlled by foliar application of SA_1 (on 15 DAT(Days After Transplanting) @ 50 ppm) and PS_2 (on 30 DAT @ 3 %) during 2018 & 2017. It was followed by foliar application of SA_1 (at 15 DAT) and SA_2 (at 30 DAT) which recorded a disease incidence during both field trials. The test fungicide Hexaconazole 0.1 per cent recorded also minimum per cent disease incidence on both field trials. The per cent sheath blight incidence was found higher in untreated control.**

Keywords: **rice brown leaf spot, Plant activator, Silicon based nutrient.**

1. INTRODUCTION

Rice is a monocotyledonous annual grass belong to family Gramineae and genus *Oryza*. Currently China and India are ranked 1st and 2nd in rice production according to Foreign Service Association of United States of Department of Agriculture Statistics. Over 90 % of the world's rice is produced and consumed in the Asian region with 6 countries (China, India, Indonesia, Bangladesh, Vietnam and Japan) accounting for about 80 % of the world's production and consumption (Abdullah *et al.*, 2015). It is grown in tropical and subtropical regions of the world. In the world, it occupies an area of 161.29 m ha with a total production of 480.02 mt with a productivity of 4.44 t/ha, and in India, it occupies an area of 44.50m ha with a total productivity of 3.59 t/ha during January 2017 (USDA Foreign Agriculture Services, January 2017).

Rice production worldwide is affected by various biotic and abiotic stresses (Richa *et al.,* 2016). Among biotic stresses, diseases are considered as major constraints for rice production as 10 to 30 per cent of the annual rice harvest is lost due to infection by many diseases. (Skamnioti and Gurr, 2009). Rice cultivation is often subjected to several biotic stresses of which diseases like blast, sheath blight, stem rot and bacterial blight are the important ones (Ou,1985). Sheath blight is one of the serious diseases of rice caused by *Rhizoctonia solani* Kuhn. Many methods of plant disease control are presently being used to control the rice sheath blight disease such as, physical, chemical and cultural methods. Normally fungicides are primary means of controlling sheath blight. But the use of chemical fungicides is under special scrutiny for posing potential environmental threat as the indiscriminate use of chemical fungicides resulted in environmental pollution and ill-health to biotic community as a whole. Even if acceptable fungicides are applied the pathogen often develops resistance and produce new biotypes. The increased consumer preference for healthy agricultural products and environmental risks associated with chemical residues in food are the major driving forces for the search of new safer control methods.

Bio control plant disease management by the use of antagonistic microorganisms is a potential non-chemical means and is known to be cheap and effective. But, the level of acceptance of existing microbial inoculants by the farming community is less than one per cent of the total pesticide market share (Deliopoulos *et al.*, 2010). So, a need was felt to develop novel, more effective and sustainable disease management programs which do not harm the environment at the same time increase yield and improve product quality (Dordas, 2008).

In recent decades new type of agro chemicals called "plant activators" which protect plant by activating their defense system have been widely used because of their low health and environment risk. Induced resistance by chemicals may provide an efficient approach to plant protection especially for problems not satisfactorily controlled by various fungicides (Schoenbeck, 1996). Resistant inducing chemicals are known as inducers of phytoalexins and/or elicitors of resistance in different plant species (Hadi and Balali, 2010). Besides, a promising alternative for the control for many rice diseases, including sheath blight, is the application of silicon (Si) to soils deficient in this element (Datnoff *et al*., 2007). In recent years, silicon (Si) is being used for the control of fungal diseases with promising results (Yanar *et al.*, 2011) and silicon accumulation has been reported to be one of the main factors responsible for enhanced resistance against various pathogens of rice (Junior *et al*., 2009). In this context balanced nutrition seems to be a promising alternative for the control of brown spot (Carvalho *et al.*, 2010).

Therefore, with an aim to develop combined strategy involving the use of resistance inducing chemicals and silicon based nutrients for the successful sustainable management of rice sheath blight.

2. MATERIALS AND METHODS

The effective concentrations were observed in different experiments conducted under pot conditions (screened trails) were pooled together and a new schedule of treatments in an individual and combination was evolved based on different crop growth stages for the effective management of sheath blight disease of rice. The treatment details are given below;

Treatment schedule:

T_1 – SA_1

T_2 - SA_2

T_3 –PS_1

T_4 – PS_2

T_5 – T_1+ T_2

T_6 – T_3 + T_4

T_7 – T_3 + T_2

T_8 – T_1 + T_4

T_9 –Hexaconazole 5 SC @ 0.1per cent as foliar spray (comparison)

T_{10} – Control

The treatment details are given below;

T_1 – Spray with salicylic acid @ 50 ppm on 15 DAT ; T_2 - Spray with salicylic acid @ 50 ppm on 30 DAT ; T_3 - Spray with potassium silicate @ 3 % on 15 DAT ; T_4 - Spray with potassium silicate @ 3 % on 30 DAT; T_5 - Two sprays with salicylic acid @ 50 ppm on 15 and 30 DAT; T_6 - Two sprays with potassium silicate @ 3 % on 15 and 30 DAT; T_7 - First spray with potassium silicate @ 3 % on 15 DAT + second spray with salicylic acid @ 50 ppm on 30 DAT; T_8 - First spray with salicylic acid @ 50 ppm on 15 DAT + second spray potassium silicate @ 3 % on 30 DAT; T_9– Hexaconazole 5 SC @ 0.1per cent as foliar spray (comparison); T_{10} - Un treated control. The sprayings were given at the time of disease initiation and repeated once at fortnightly intervals.

The intensity of sheath blight was calculated as per cent disease index (PDI) as per the grade chart proposed by (Sriram *et al.*, 2000).

0 = No infection

1 = Less than 5 per cent of the area of leaf sheath affected

2 = 6-10 per cent of the area of leaf sheath affected

3 = 11-25 per cent of the area of leaf sheath affected

4 = 26-50 per cent of the area of leaf sheath affected

5 = More than 50 per cent of the area of leaf sheath affected

The per cent disease index (PDI) was calculated as given by McKinney (1923).

$$\text{PDI} = \frac{\text{Sum of numerical ratings}}{\text{Total number of tillers observed}} \times \frac{100}{\text{Maximum category value}}$$

3. RESULTS AND DISCUSSION

Percent Disease Incidence:

In field experiments, foliar application of salicylic acid and potassium silicate were found significantly superior over test fungicide Hexaconazole in respect of reducing disease intensity and increasing biometrics and yield parameters of rice. Results (Table 1) of the study showed that, sheath blight disease incidence was effectively controlled by foliar application of SA_1 (at 15 DAT) and PS_2 (at 30 DAT) during 2018 & 2017(6.22 % & 05.00). It was followed by (T_5) foliar application of SA_1 (at 15 DAT) and SA_2 (at 30 DAT) which recorded a disease incidence during 2017 & 2018. The test fungicide Hexaconazole 0.1 per cent recorded 09.50 per cent during 2018. The per cent sheath blight incidence was found higher (38.44 %) in untreated control during 2018.

Some economically important diseases in rice such as blast, brown spot, stem rot and grain discoloration have been reduced by silicon nutrient application with increased production (Zhang *et al.*, 2006; Santos *et al.*, 2011; Yanar *et al.*, 2011). Also, in many countries crops such as rice and sugarcane which accumulate high levels of Si in plant tissue are fertilized routinely with calcium, potassium silicate to produce higher yields and higher disease resistance (Dordas, 2008).

Plants supplied with silicon exhibit potentiated activation of the phenylpropanoid pathway resulting in increases in total soluble phenolics and lignin (Rodrigues and Datnoff, 2015). The activities of plant defense enzymes, such as chitinases, peroxidase, poly phenol oxidase and β-1,3-glucanases, are increased in cucumber plants due to application of silicon along with *Pythium ultimum* inoculation (Cherif *et al.*, 1994). When plants are supplied with silicon and then challenged with a pathogen, there is an enhanced activation in antioxidant metabolism, which in turn, suppresses the damaging cytotoxic effect of the reactive oxygen species that causes lipid peroxidation in the cell membrane (Torres *et al.*, 2006).

The induction of systemic resistance in crops by exogenous application of SA represents a potentially valuable method in pathogen management strategies complementary to conventional control methods. It is evident that SA is an important endogenous signal molecule involved in the transduction pathway and is required for the establishment of SAR (Shulaev *et al.*, 1995). SA also affects the lipid peroxidation, which plays a key role in initiating defense response (Anderson *et al.*, 1998) and induction of SAR in plants when challenged with pathogens (Maldonado *et al.*, 2002; Nandi *et al.*, 2004). Besides the function of biotic and abiotic stress management, SA plays a crucial role in the regulation of physiological and biochemical process during the entire life span of the plant (Vicente and Plasencia, 2011). The beneficial influence of SA on the growth and yield was also established by earlier workers (Vlot *et al.*, 2009).

In recent research, resistance inducing chemicals are applied singly to combat a pathogen. But, the results of the present study have proved that combined application of resistance inducing chemical, silicon based macro-micro nutrient exhibited a general trend towards a greater conquest of sheath blight caused by *R.solani.* Such enhanced suppression exerted by resistance inducing chemicals may be due to the induced systemic resistance (ISR). It adds another advantage over the use of fungicides in disease management strategies. Also, the obtained results confirm the importance of foliar spray with micronutrients as a complementary tool in disease's management strategies with increasing yield to obtain sustainable agriculture.

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APPENDIX - A

Table 1: Impact of SA, PS in different combinations on the incidence of Sheath blight under field conditions

T.No.	Treatments	2018		2017	
		Disease incidence (%)	% decrease over control	Disease incidence (%)	% decrease over control
1	$T_1 – SA_1$	09.82	74.45	10.08	76.80
2	T_2 - SA_2	10.58	72.47	15.11	65.26
3	T_3–PS_1	12.16	68.36	14.22	67.31
4	T_4– PS_2	11.36	70.44	13.05	70.00
5	T_5– T_1+ T_2	08.20	78.66	08.39	80.71
6	T_6– T_3 + T_4	08.90	76.84	08.50	81.38
7	T_7 – T_3 + T_2	09.02	76.53	08.60	80.22
8	T_8 – T_1 + T_4	06.22	83.81	05.00	88.50
9	T_9 –Hexaconazole 5 SC @ 0.1per cent	09.50	75.28	07.68	82.34
10	T_{10} – Control	38.44	_	43.50	--