Impact of Zinc sulphate, Salicylic Acid and Potassium Silicate in different combinations on grain characters of rice var. ADT 36

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Abstract

The Pot culture studies were undertaken to investigate the macro nutrients in rice as influenced by application of Zinc sulphate and foliar application of salicylic acid and Potassium silicate and Brown spot pathogen *Bipolaris oryzae* inoculation. The results revealed that Soil application of Zinc sulphate @ 25 kg/ ha along with foliar application of plant activator Salicylic acid @ 50 ppm on 15 days after transplanting and Foliar spray of silicon based nutrient potassium silicate @ 3 % recorded the minimum disease incidence and maximum biometrics of rice. Also, the same treatment T_6 recorded the maximum filled grain percentage, minimum level of grain discolouration and chaffy grains when compared to control treatments and comparison fungicide.

Introduction

Rice, which is being cultivated for several years in our country, it is not just a grain, it is the lifeline and is the second most important crop next to wheat. India is one among the leading producer of rice in Asia [22]. Rice crop has been under cultivation from time immemorial, being grown under varying climatic conditions in different parts of the country. It is widely affected by quite a number of diseases caused by fungi, bacteria, viruses and mycoplasma which results in higher yield losses [15]. Among the various fungal diseases of rice, brown spot or sesame leaf spot incited by *Helminthosporium oryzae* (Breda de Haan) Subram. And Jain (Current name: *Bipolaris oryzae* (Breda de Haan) Shoemaker) is found to occur in most rice growing areas.

Currently the disease is being managed by application of fungicides. Due to pesticides hazards, pollution effect, fungicide resistant, bio control agent resistant strains, lack of bioprotectant knowledge which required the integrated component approach in Indian farmer's level which will be improve growth and disease suppression.

Growth promoting response was generated in barley seedlings sprayed with salicylic acid [16]. The foliar application of salicylic acid to soybean also enhanced the flowering and pod formation [12]. Similarly, enhanced germination and seedling growth were recorded in wheat, when the grains were subjected to pre-sowing seed-soaking treatment in salicylic acid [20]. Silicon (Si), the second most abundant element of the Earth's crust, has been well relied upon by our ancestors, although unknowingly, for protection against fungal diseases, such as damping-off [23] and powdery mildew of cucumber [2]. A review by Epstein [6], considered the role of silicon on plant disease management. Silicon is known to reduce infection on various crop plants, partially through the induction of plant defences [3,25]. Also, several studies have confirmed that the severity of powdery mildew on cucumber, wheat and grape can be reduced through foliar or soil applications of potassium silicate [9,27].

Foliar sprays of potassium silicate reduced the incidence and severity of angular leaf spot of beans caused by *Pseudocercospora* sp. [19] and powdery mildew disease in tomato caused by *Leveillula Taurica* [27]. Liquid potassium silicate applications have resulted in reduced severities of powdery mildew on strawberry [9] and grape [28]. Several authors reported on the use of zinc sulphate for managing the plant diseases ([10, 17, 24]. Application of zinc fertilizers to Indian soil increased the resistance to disease, better seed viability and seedling vigour, improved abiotic stress tolerance and higher yield [4].

Therefore, with an aim to develop an integrated strategy involving the use of certain macro-micro nutrients, silicon based nutrients and resistance inducing chemicals for the successful sustainable management of rice brown spot. Hence, the present studies were undertaken to investigate the grain characters of rice by application of Macro-micro nutrient, Salicylic acid, potassium silicate along with pathogen inoculation.

Materials and Methods

Crop, Variety and Source

Crop : Rice (*Oryza sativa* L.)
Variety : ADT 36
Source : Tamil Nadu Rice Research Institute (TRRI), Aduthurai, Tamil Nadu.

-Pot culture studies

The pot culture studies was conducted to test the efficacy of certain macro-micro nutrients, silicon based nutrients and certain resistance inducing chemicals for assessing their influence on the incidence of brown spot of rice with various treatment and combinations. The brown spot susceptible variety ADT 36 grown in rectangular pots of size, 30x45 cm was used for the study. The plants were given artificial inoculation by spraying the spore suspensions with adequate spore load (50,000 spores/ml) at 15 DAT in the evening hours. The crop was maintained in a poly house with frequent spraying of water to provide adequate moisture and relative humidity to enable successful infection by the pathogen. The experiments were conducted in a randomized block design with three replications for each treatment and a suitable control. The fungicide carbendazim 50 WP @ 0.1 per cent was used for comparison and the standard agronomic practices as recommended by the State Agricultural Department were followed.

The effective treatments observed in different experiments conducted under pot and field conditions were pooled together and a new schedule of treatments in combination was evolved for the effective management of brown spot disease of rice. Also, zinc sulphate @ 25 Kg/ha was applied as basal application to the entire treatments (ZSS) except control and comparison. The treatment details are given below;

Treatment schedule

T_1 – ZSS + ZSF_1 + ZSF_2
T_2 – ZSS + SA_1 + SA_2
T_3 – ZSS + PS_1 + PS_2
T_4 – ZSS + ZSF_1 + SA_2
T_5 – ZSS + SA_1 + ZSF_2
T_6 – ZSS + SA_1 + PS_2
T_7 – ZSS + PS_1 + SA_2
T_8 – ZSS + PS_1 + ZSF_2
T_9 – ZSS + ZSF_1 + PS_2
T_{10} – Carbendazim 50 WP @ 0.1 per cent as foliar spray (comparison)
T_{11} – Control

$ZnSO_4$ @ 25 Kg/ha was applied as basal application to the entire treatments (ZSS) except control and comparison. The treatment details are given below;

T_1 – ZSS + Two sprays of zinc sulphate @ 3 % on 15 and 30 DAT

T_2 - ZSS + Two sprays with salicylic acid @ 50 ppm on 15 and 30 DAT.

T_3 - ZSS + Two sprays with potassium silicate @ 3 % on 15 and 30 DAT.

T_4 - ZSS + First spray with zinc sulphate @ 3 % on 15 DAT + second spray with salicylic acid @ 50 ppm on 30 DAT.

T_5 - ZSS + Second spray with zinc sulphate @ 3 % on 30 DAT

T_6 - ZSS + First spray with salicylic acid @ 50 ppm on 15 DAT + second spray with potassium silicate @ 3 % on 30 DAT

T_7 - ZSS + First spray with potassium silicate @ 3 % on 15 DAT + second spray with salicylic acid @ 50 ppm on 30 DAT

T_8 - ZSS +First spray with potassium silicate @ 3 % on 15 DAT + second spray with zinc sulphate @ 3 % on 30 DAT

T_9 - ZSS + First spray with zinc sulphate @ 3 % on 15 DAT + second spray with potassium silicate @ 3 % on 30 DAT

T_{10} – Carbendazim (0.1 %) – Comparison

T_{11} - Un treated control.

The filled grain, Chaffy grains and grain discolouration recorded from all the three replication and the average values given in the results.

Statistical analysis

The statistical analysis of the experimental results was performed employing the computer software package 'IRRISTAT', version 90-1, developed by Department of Statistics, International Rice Research Institute, Philippines and as per the procedure of Gomez and Gomez [7].

Results and Discussion

Grain characters

The positive influence of various treatments on the grain characters of rice was depicted in table 1 and 2. The treatment T_6 recorded the maximum filled grain percentage (84.48 and 82.36), minimum level of grain discolouration (04.32 and 05.15) and chaffy grains (10.72 and 12.74) when compared to control treatments during both years, respectively.

Application of micro nutrients such as Mn, Zn, Cu and B can increase the Ca^{2+} cations and interact with SA and activate ISR [18,5]. Zinc is a component of dehydrogenases, peptides and many other enzymes and also regulates synthesis of auxins in plant [8] and thus may play important role in conferring resistance to host. The effect of the micronutrients on reducing the severity of foliar diseases can be attributed to the involvement in physiology and biochemistry of the plant as the micronutrients are involved in many processes that can affect the response of plants to pathogens [14]. Results of the present investigations clearly proved that $ZnSO_4$ induced appreciable resistance in rice plants against *H. oryzae* and the reduction in disease incidence reflected in the increased yield as well. Earlier workers have also recorded the involvement of Zn in the resistance of plants to diseases and increases the plant growth characters [13, 26, 11].

Alagarsamy [1] reported that macro-micro nutrients spray during tillering and boot leaf stage of rice reduced the sheath rot disease incidence. He also stated that one of the probable reasons attributed for decrease in disease intensity in macro-micro nutrients spray treatment was the reduction in enzyme activity, increased phenols and sugars which led to the development of resistance in rice plants as observed in the present study.

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. Naturally induced SAR was not predictable in timing and level of expression and therefore, it could not be useful for agricultural practice. Hence, a novel approach of using synthetic signal molecules to induce SAR in crop plants had emerged. It is evident that SA is an important endogenous signal molecule involved in the transduction pathway and is required for the establishment of SAR [21].

Also, the obtained results confirm the importance of foliar nutrition with micronutrients as a complementary tool in disease's management strategies to obtain sustainable agro productivity. Besides, an integration of several strategies like application of resistance inducing chemical, macro-micro nutrient along with silicon based nutrient would certainly benefit in the management of foliar pathogens and enhance the crop yield as observed in the present study.

The combination treatment consisting of ZSS, SA_1 and PS_2 (T_6) increases the grain quality characters when compared to control and fungicide treatments.

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Table 1. Impact of ZS, SA and PS in different combinations on grain characters of rice var. ADT 36 (navarai season)

T.No	Treatments	Filled grain (%)	Grain discolouration (%)	Chaffy grain (%)
1	ZSS + ZSF_1 + ZSF_2	80.12	05.72	16.32
2	ZSS + SA_1 + SA_2	80.98	05.27	14.88
3	ZSS + PS_1 + PS_2	80.37	05.63	15.76
4	ZSS + ZSF_1 + SA_2	81.56	04.96	13.97
5	ZSS + SA_1 + ZSF_2	82.15	04.73	13.52
6	ZSS + SA_1 + PS_2	84.48	04.32	10.72
7	ZSS + PS_1 + SA_2	83.60	04.47	12.70
8	ZSS + PS_1 + ZSF_2	80.64	05.44	15.19
9	ZSS + ZSF_1 + PS_2	81.19	05.12	14.63
10	Carbendazim	75.84	08.50	15.60
11	Control	56.32	14.32	30.21
	C.D. (p=0.05)	0.12	0.06	0.14

Table 2. Impact of ZS, SA and PS in different combinations on grain characters of rice var. ADT 36 (navarai season on next year)

T.No	Treatments	Filled grain (%)	Grain discolouration (%)	Chaffy grain (%)
1	ZSS + ZSF_1 + ZSF_2	79.65	06.14	15.49
2	ZSS + SA_1 + SA_2	80.91	05.92	14.97
3	ZSS + PS_1 + PS_2	80.11	06.05	15.37
4	ZSS + ZSF_1 + SA_2	81.65	05.62	14.18
5	ZSS + SA_1 + ZSF_2	81.79	05.47	13.82
6	ZSS + SA_1 + PS_2	82.36	05.15	12.74
7	ZSS + PS_1 + SA_2	82.03	05.29	13.66
8	ZSS + PS_1 + ZSF_2	80.47	05.97	15.15
9	ZSS + ZSF_1 + PS_2	81.58	05.75	14.55
10	Carbendazim	76.25	09.75	13.50
11	Control	54.08	16.62	30.73
	C.D. (p=0.05)	0.14	0.08	0.16