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Research Article

COMBINED APPLICATIONS OF FUNGICIDES, BOTANICAL FORMULATIONS AND BIOCONTROL AGENT FOR MANAGING RICE BLAST CAUSED BY *MAGNAPORTHE GRISEA* UNDER TEMPERATE CONDITIONS OF KASHMIR

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ABSTRACT

Rice is the world's most important food crop as it provides nutrition to the two third of its population. The improvement in yield of this crop is challenged by several biotic and abiotic factors. Among the biotic stresses, rice blast is a serious production constraint for rice in Kashmir conditions. Keeping in view the above fact, an investigation was carried out at two locations viz, Anantnag and Pulwama using Randomised Block Design (RBD) with three replications during Kharif 2018-2019 to check the efficacy against leaf and neck blast disease of rice variety K-448 with Tricyclazole (75WP) 1g l^{-1}, Hexaconazole (5EC) 2.5ml l^{-1} and Mancozeb (45WP) 1g l^{-1} as chemical fungicides, *Trichoderma harzianum* as biocontrol agent and leaf extracts of *Datura stramonium* and *Cannabis sativa* (15%) as botanicals in experimental plots. The treatments were applied three times in the field at tillering, booting and neck blast stages. Leaf and neck blast percent disease intensity and total yield were recorded using Standard Evaluation System for rice (SES 0-9). All the spray treatments proved effective and reduced leaf and neck blast intensity and significantly increased the yield parameters. Among all treatments, Tricyclazole (beam) was found significantly superior and recorded minimum leaf blast intensity (8.54%), neck blast intensity (21.20%) and remarkably significant increase in grain and straw yield (3303kgh^{-1}and 6001kgh^{-1}). The next best treatment was *T.harzianum* which registered leaf blast intensity (13.06%) and (34.43%) neck blast intensity at both locations and was found statistically at par with Hexaconazole (14.17% and 36.94%) followed by Mancozeb (19.11% and 42.02%) and *Datura stramonium* (25.65% and 46.13%). Maximum leaf and neck blast (40.15% and 57.97%) was observed with *Cannabis sativa* leaf extract but showed numerically higher grain (2069 kg/ha) and straw yield (4509 kg/ha) as compared to untreated control.

Keywords: Blast, Botanicals, Biocontrol agent, Fungicides, *Magnaporthe grisea*, Rice.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for more than 60 percent of the world's population and more than 90 percent of the rice produced in the world is consumed in the Asian countries [1]. The global rice demand is estimated to rise from 6.76×108 t in 2010 to 8.52×108 t in 2035. To produce 6.76×108 t additional rice, it is needed to increase the yield and also minimize the yield loss caused by various diseases and insect pests [2]. Rice (*Oryza sativa* L.) is staple food in Kashmir and continuous research efforts have therefore been made to produce varieties with improved levels of disease resistance [3]. The crop in valley is frequently challenged by various biotic and abiotic stresses throughout the growing season [4]. Among all, rice blast caused by *Pyricularia grisea* Sacc [Telipomorph *Magnaporthe grisea* (Hebart) Brarr] is one of the important factors for low productivity of rice in the valley and is a major constraint for sustainable rice production [5]. The fungus causes lesions on leaves, stems, peduncles, panicles, seeds, and even roots [6]. The pathogen is known to attack paddy crop on various stages *viz.,* seedling, tillering and panicle emergence stages [7]. The blast disease alone is estimated to cause more than US$55 million production losses at each year in South and Southeast Asia. The losses are even higher in East Asia and other more temperate rice growing regions around the world [8].

Management of rice blast is difficult because the pathogen is seed-borne. Management approaches have mainly focused on the use of synthetic chemicals and resistant rice varieties [9]. Several chemicals have been applied for controlling rice blast [10-13]. However, their frequent use on crops may cause hazards to human beings, plant health, beneficial micro-organisms, and develop fungicide resistance into the pathogens and residual toxicity in plant parts [14]. On the other hand, some botanical pesticides and bio-control agents have proved to be most secure and have no adverse impact on environment [15, 16]. The various chemicals, antagonists and botanicals were also recommended in different area to control the blast [17]. The purpose of this study was to evaluate comparative efficacy of different chemical fungicides, plant extracts and biocontrol agent against *Magnaporthe oryzae* causing rice blast.

2. MATERIAL AND METHODS

2.1. Preparation of plant leaf extract

Two plants viz., *Datura stramonium* and *Cannabis sativa* were selected for the study. Healthy non infected leaves of these plants were collected from the local area of Anantnag Kashmir, India. Extracts were prepared from these locally and commercially available plants. Fresh leaves of the selected plants were taken and thoroughly washed in tap water to remove the dust, and then leaves of each plant were chopped and macerated with mortar and pestle or by using the automated grinder in equal quantity (1:1) of distilled water. Then this material was taken in a beaker and boiled at 80°C for ten minutes in a hot water bath. The material was homogenized for five minutes and filtered through muslin cloth. The filtrate was centrifuged at 5000 RPM for fifteen minutes and the clear supernatant was collected and filtration then designated as standard (S). The standard solution(S) was further diluted (15%) by adding required amounts of distilled water. Three sprays of each standard solution (15%) were practized by foot sprayer with fine nozzle on the transplanted crop at productive stages viz; tillering, booting and neck blast stages.

2.2. Evaluation of Bio-agent and fungicides

The bio-agent (*Trichoderma harzianum*) was collected from the preserved isolates of Rice Research and Regional Station (SKUAST-K), Khudwani Anantnag Kashmir, India. To get more culture of this bio-agent, it was grown in 250 ml Erlenmeyer flasks contained 100ml sterilized potato dextrose agar (PDA) medium and kept in BOD at 28°C for seven days. After incubation, the lawn of bio-agent was filtered through the muslin cloth and made the spore suspension (2×10^8 spores/ml). After 3 days, average numbers of colonies per plate of the bio agent was observed and the number of colony forming unit (c.f.u) present was calculated by the formula [18].

c.f.u = No. of colonies / (Amount plated X dilution factor)

Three fungicides viz, Tricyclazole (75WP) 1g l^{-1}, Hexaconazole (5EC) 2.5ml l^{-1} and Mancozeb (45WP) 1g l^{-1} as foliar sprays were also evaluated for the management of the disease.

2.3. Field Trial

In order to get an effective control and combating yield losses, an experiment on integrated management of rice blast disease was conducted during Kharif 2018-2019 at two locations on farmer's field viz, Anchidora Anantnag and Ratnipora Pulwama (J&K), India. Three fungicides-Tricyclazole 75WP @1.0gm per litre of water, Hexaconazole 5EC@2.5ml per litre of water and Mancozeb 45WP@1.0gm per litre of water, bio-agent *Trichoderma harzianum* @ $2\text{x}10^8$cfu g^{-1} and leaf extracts of commercially and locally available medicinal plants *Datura stramonium* and *Cannabis sativa* (15%) along with the untreated control were used as foliar sprays and applied three times with ten days interval at 65,75 and 85 DAT on highly susceptible rice variety K-448 after appearance of the disease at three productive stages viz, tillering, booting and flowering stages. Adequate precautions were taken to avoid drifting of spray materials from one plot to the neighbouring ones. One month old seedlings were transplanted in plot size $2\text{x}5m^2$ in randomized block design (RBD) with three replications. Spacing was maintained plant to plant 10cm and row to row 20cm. The experimental soil was clay loam in texture with 7-7.4 pH. Recommended agronomical practices in vogue were followed for raising healthy seedlings for entire period of crop. Observations on leaf and neck blast percent disease incidence, severity on different stages of crop from 30 hills/plot randomly selected were recorded by using Standard Evaluation System for rice (SES 0-9), IRRI (1988). The percent disease incidence and severity was worked out by using the formula:

Incidence %=(No. of samples affected with disease/No. of sample observed) x 100

Severity %={(Sum of the scores of diseased samples) /(No. of samples scored x highest score)} x 100

The grain and straw yield/plot at both the locations were recorded and analysed statistically.

3. RESULTS AND DISCUSSION

3.1. Effect of treatments on leaf and neck blast

Results reported in (Table 1) revealed that all the treatments are found to be lethal and had significantly reduced the percent leaf and neck blast as compared to control at both the locations. The efficacy of both the fungicides was almost same in controlling the disease at both the locations and location pooled analysis.

Among all treatments, Tricyclazole (beam) was found significantly superior and recorded minimum (8.54%) leaf blast intensity and (21.20%) neck blast intensity. It is shown that tricyclazole are melanin biosynthesis inhibitors (MBI) group fungicide and prevent melanin biosynthesis in appressoria of *Pyricularia oryzae* and penetration of rice plants via appressoria by inhibiting polyhydroxynapthaline reductase [19]. Our findings are in line with Iqbal, Neelakanth and Gohel [11, 17, 20] who reported that Tricyclozole was most effective in reducing the leaf blast severity.

T.harzianum was next best treatment which impeded disease occurrence and showed (13.06%) and (34.43%) disease intensity which was statistically at par with Hexaconazole (14.17%) and (36.94%), followed by Mancozeb (19.11%) and (42.02%) and *Datura stramonium* leaf extract (25.65%) and (46.13%) respectively. It is obvious *Trichoderma spp*. has positive response on the seed germination and also reduced the intensity of blast disease of rice [21]. Under in vitro condition, four species of *Trichoderma* proved 100% potential inhibition against rice blast pathogen *Pyricularia oryzae* [22]. Previous investigation by Magar *et al*. [12] have reported that Tricyclazole 22% + Hexaconazole 3% SC was found to be the most effective with least leaf blast severity (6.23%), neck blast incidence (8.97%), and highest percentage disease control (87.08% and 79.62%) in leaf and neck blast respectively and grain yield (4.23 t/ha).

Maximum disease intensity was observed with *Cannabis sativa* leaf extract (40.15%) and (57.97%) in location pooled analysis. Similar results were obtained by Dar *et al.* [23] who evaluated different botanicals against blast disease and reported that among all tested botanicals, *P. communis* was found most effective while as *Cannabis sativa* was found less effective.

3.2. Effect of treatments on grain and straw yield

Results reported in (Table 2) revealed that the yield of grain and straw at both locations and location pool analysis were significant. Tricyclazole when applied as foliar spray greatly exterminated disease spread resulting remarkable and significant increase in grain yield (3303kg/ha) which was at par with *T.harzianum* (3149kg/ha) and Hexaconazole (2909kg/ha). Tricyclazole, kitazine and ediphenphos were found significantly superior in increasing the grain yield [24, 25].

Grain yield performance of Mancozeb (2686 kg/ha) and *Datura stramonium* leaf extract (2407 kg/ha) were also superior over control treatment (1911kg/ha). Treatment of *Cannabis sativa* leaf extract gave numerically higher grain yield (2069 kg/ha) as compared to untreated control but was at par with control treatment in grain yield performance.

The straw yield performance was similar to that of grain yield due to different treatments at both locations and in pool analysis. The straw yield was significantly highest (6001 kg/ha) in Tricyclazole which was at par with *T.harzianum* (5694 kg/ha) and Hexaconazole (5583 kg/ha). Straw yield performance of Mancozeb (5402 kg/ha) and *Datura stramonium* leaf extract (5130 kg/ha) were also superior over control treatment (4235 kg/ha). Similar results were found by Gohel and Chauhan [17].

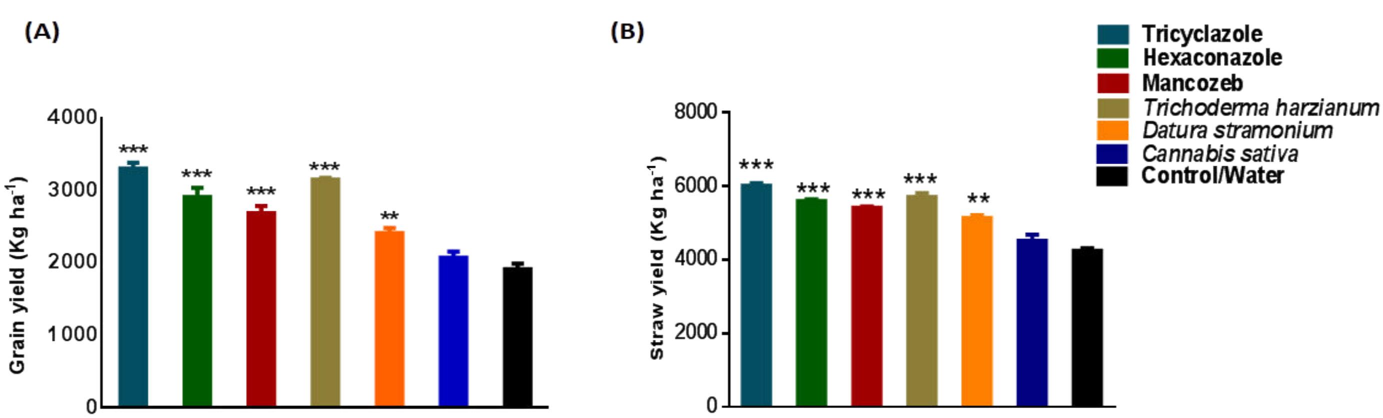

Table 1: Integrated management of rice blast disease (*Magnaporthe grisea*) on rice variety K-448

S.No	Treatments	Leaf Blast Intensity (%)			Neck blast intensity (%)		
		Anantnag	Pulwama	Pooled	Anantnag	Pulwama	Pooled
1	Tricyclazole (75WP) 1g l^{-1}	7.62 (15.89)	09.49 (17.74)	8.54 (16.82)	19.90 (27.52)	22.50 (30.25)	21.20 (26.39)
2	Hexaconazole (5EC) 2.5ml l^{-1}	13.44 (21.26)	15.90 (22.90)	14.17 (22.62)	36.24 (38.33)	37.64 (37.40)	36.94 (37.84)
3	Mancozeb (45WP)1g l^{-1}	17.50 (24.14)	20.71 (26.39)	19.11 (25.20)	38.30 (40.14)	41.75 (41.53)	42.02 (39.79)
4	*Trichoderma harzianum* 2x10^8 CFU g^{-1}	12.50 (20.50)	13.62 (23.05)	13.06 (22.79)	34.48 (37.30)	32.38 (36.09)	34.43 (34.70)
5	*Datura stramonium* (Datura leaf extract) 15%	24.67 (29.34)	26.64 (31.31)	25.65 (30.35)	42.50 (42.40)	45.76 (41.25)	46.13 (42.33)
6	*Cannabis sativa* (Bhang leaf extract) 15%	36.80 (36.49)	43.50 (41.43)	40.15 (39.46)	55.35 (49.41)	56.59 (50.12)	57.97 (48.74)
7	Control/ Water	45.54 (41.97)	50.46 (45.38)	48.00 (43.65)	58.35 (50.74)	61.79 (52.78)	63.07 (51.73)
	CD (P=0.05)	4.24	3.90	2.43	4.80	4.76	2.96

Figures outside parenthesis are original values

Figures in parenthesis are arc sine transformed values

Table 2: Effect of fungicides, bio agents and botanicals on grain and straw yield

S.No	Treatments	Grain Yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
		Anantnag	Pulwama	Pooled	Anantnag	Pulwama	Pooled
1	Tricyclazole (75WP) 1g l^{-1}	3360	3246	3303	6049	5954	6001
2	Hexaconazole (5EC) 2.5ml l^{-1}	2998	2820	2909	5620	5547	5583
3	Mancozeb (45WP)1g l^{-1}	2755	2618	2686	5426	5379	5402
4	*Trichoderma harzianum* 2x10^8 CFU g^{-1}	3167	3132	3149	5770	5619	5694
5	*Datura stramonium* (Datura leaf extract) 15%	2459	2356	2407	5180	5081	5130
6	*Cannabis sativa (Bhang leaf extract)* 15%	2129	2010	2069	4627	4392	4509
7	Control/Water	1965	1857	1911	4283	4187	4235
	CD (P=0.05)	389.22	418.39	243.49	538.25	704.60	375.19

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