Current Botany 2018, 9: 17-21
doi: 10.25081/cb.2018.v9.3548
http://updatepublishing.com/journal/index.php/cb

ISSN: 2220-4822

REGULAR ARTICLE

EFFECT OF BOTANICALS FOR MANAGEMENT OF LEAF BLAST AND ENHANCING YIELD TRAITS IN RICE

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ABSTRACT

Field experiments were undertaken during kharif 2012 and 2013 under irrigated ecosystem to evaluate the efficacy of botanicals along with standard fungicides for assessing per cent disease incidence, plant height, number of tiller per plant, number of spikelet per panicle, panicle length, 100-grain weight and grain yield against blast of rice. Pooled data of two years suggest that neem based commercial biopesticides with azadiractin as active ingredients were found effective in reducing disease severity and improving the yield attribute of the crop and proves promising products when compared to standard fungicides. Among the botanicals the spraying of Achook, Neem Azal T/S, Neem gold and Tricure shows significant reduction in disease severity, along with improving yield attributes, increasing the 100-grain weight and grain yield.

Keywords: Rice, Botanicals, Leaf blast, Yield attributes, Grain yield, Seed weight

INTRODUCTION

One of the major diseases of rice namely rice blast is caused by *Pyricularia oryzae* Cav. (*Magnaporthe grisea* Sacc.) is an important and serious disease to rice worldwide [1, 2]. The pathogen, a holomorph of a complex of heterothallic Ascomycetes, is most damaging of rice diseases [3]. It causes high yield loss about 30% globally [4], and thus major threat to global food security [5]. In India, rice blast is a major production constraint in irrigated ecosystem [6] and under severe epiphytic conditions may result a loss of 70–90% [7]. In central India the blast diseases cause significant loss in yield in traditional as well as improved varieties. The scented rice Basmati with a wide popularity among the growers has even no resistance to diseases [8] and shows high level of susceptibility under conducive weather conditions [9].

The management of rice diseases using chemicals is common [10] as the risk of the disease highly influence grain yield and requires a judicious use of fungicides [11]. However, the use of chemicals resulted in environmental pollution and ill health to biotic community as a whole, and this necessitates developing natural product as alternative to synthetic fungicides to control the disease [12]. The botanicals that are target-specific, biodegradable and relatively safe to non-target organisms should be a best alternative. Moreover, they are more compatible with components of the environment than the chemical owing primarily due to their susceptibility to degradation by heat, light and microorganisms [13] and worth as they are economical and feasible [14]. The management of rice diseases using botanicals has been reported to be significant [15-17]. Therefore, this study has been designed to evaluate the efficacy of botanicals for leaf blast management and enhancing the yield traits of rice under irrigated ecosystem.

MATERIALS AND METHODS

The field trials were laid out in a randomized block design (RBD) with three replications in each. The experiment was conducted in Rewa (24'18 and 25'12 north latitudes and 81'2 and 82'18 east longitudes), Madhya Pradesh, India during rainy season 2012 and 2013. Blast susceptible variety "Basmati" was transplanted in a plot of 5m x 3m size at 15 cm x 15 cm spacing. Fertilizers were applied @ 80:60:40 kg ha^{-1} of N, P_2O_5 and K_2O respectively. Seven commercially derived botanicals with azadiractin as active ingredients viz. Achook 5 ml l^{-1}(Azadirachtin 0.15% a. i), Biotos 2.5 ml l^{-1}(Plant activator-Monoterpenes a. i.), Neem Azal T/S 3.5 ml l^{-1}(Azadirachtin a. i), Neem gold 5 ml l^{-1}(Azadirachtin 0.15% a. i), Spictaf 4.5 ml l^{-1}(Azadirachtin a. i), Tricure 5 ml l^{-1} (Azadirachtin 0.03% a. i)and Wanis 5 ml l^{-1}(Plant activator-Monoterpenes a. i.), along with two standard fungicides Bavistin 1g l^{-1} (Carbendazim 50% WP a. i.) and Hinosan1g l^{-1} (Ediphenphos 50% EC a. i.) were evaluated, over control. Three sprays of plant-derived commercial products were carried out at ten days interval, starting with the incidence of the disease. Disease incidence was recorded firstly at initial stage before spraying the products, secondly after one week and finally at harvest. Five plants from each plot were randomly selected and from each selected plants, three leaves were selected for recording disease index. The disease incidence was recorded by using 0-9 scale [18] at weekly interval and percent disease index

Received 07 January 2018; Accepted 21 March 2018

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(PDI) was calculated using the formula.

$$\text{PDI} = \frac{Sum of\ numerical\ ratings \times 100}{Total number of\ leaves\ observed \times Maximum disease\ scale}$$

The observations of yield contributing characters viz. Plant height, tiller numbers, number of spikelet and panicle length were determined at harvest.

Percent increase in yield (PIY) was calculated by the following formula

$$PIY = \frac{yield\ of\ treated\ \ plot\,(q\,ha^{-1}) - yield\ \ in\ control(q\,ha^{-1}) \times 100}{Yield\ \ in\ control(q\,ha^{-1})}$$

Percent increase in seed weight was determined by the formula

$$\frac{\text{Seed weight in treatment} - \text{seed weight in control}}{\text{seed weight in control}} \text{x}100$$

Statistical analysis

All data in tables are shown as means of three replicates. Two-way ANOVA was used for statistical analysis and Fisher's test using the Excel 2007.

RESULTS

The efficacy of botanicals along with standard fungicides on the incidence of leaf blast was assessed (Table-1). The pooled mean value of both the years shows significant variation in yield attribute, grain-yield and 100 seed-weights. It was observed that different yield trait responded differently in all the treatments. From the foregoing result it was observed that the botanicals with azadiractin as active ingredients were proved impressive when compared to standard fungicides in reducing disease severity and improving the yield attribute.

In the year 2012 the disease index was found in the range of 14.8 to 26.8%. The suppression in disease severity in the plots sprayed with the botanicals gave encouraging results. Among the botanicals, Achook was found significantly effective in managing the leaf blast (20.2%) closely followed by Neem Azal T/S (20.4%) and Neem gold. Similarly, in the year 2013 the disease control mechanism using fungicides and botanicals follows the previous year patterns. Though the disease index was comparatively more than previous year, the rate of disease suppressions was statistically effective. A promising disease reduction was observed in plot treated with Achook. The product Neem Azal T/S and Neem gold were found statistically at par with each other against the blast pathogen. The other botanical products also show a better performance in reducing leaf blast severity.

Application of botanical product was found astonishing when compared with standard fungicides in increasing the yield attributes (table 2). The pooled data of two years shows a remarkable variation in all the yield attributes. Among the botanicals the application of Achook, Neem Azal T/S and Neem gold shows noticeable improvement in plant height and were found promising products. Similar trend was also observed in other yield attributes. The plot sprayed with botanicals gave distinct result however less comparable to standard fungicides. The spraying of Achook at 7 DAS, 14 DAS and 21 DAS resulted in effective number of tillers per plant. The spraying of Neem Azal T/S and Neem gold also showed statistically equivalent number of tillers and proved to be promising botanical products. In case of number of spikelet per panicle botanicals gave encouraging responses and Achook followed by Neem Azal T/S and Neem gold was proved most promising in increasing the number of spikelet per panicle. Similar trend was also noticed in improving panicle length when three applications of Achook followed by Neem Azal T/S and Neem gold at regular interval were found noticeable in increasing the panicle length of the tested cultivar.

The grain yield and 100 seed weights were assessed for all the treatments (table 3). The pooled data of two years shows significant variations in grain yield and 100-seed weight. Effective increase in yield was reported in the plots sprayed with botanicals. The spraying of Achook recorded better increase in grain yield (29.97%), along with Neem Azal T/S and Neem gold with an increase of 22.85 and 20.30% respectively. Similar pattern was also followed in improving 100-seed weight. The application of botanicals shows better performance in improving seed weights with maximum in Achook followed by Neem Azal T/S and Neem gold treated plot.

DISCUSSION

Rice is the principal food crop and its yield mainly depends on various natural and agronomic factors. Various biotic and abiotic stresses are accountable for low yield but major constraints to rice production are the diseases outbreaks that produce real threats to both conventional and organic farming [19]. The information about the host-pathogen chemistry is an important part of plant defense mechanism as the disease outbreak causes severe economic loss to the crop [20]. The use of chemical is common in blast control but their indiscriminate use causes serious threat to the environment [21]. In recent years, improved chemical methods like use of organomercuric, organophosphorus and copper fungicides, antibiotics like Kasugamycin and Blasticidin S, site specific and systemic fungicides including melanin biosynthesis suppresser and plant activators and leaf extracts are utilized successfully for blast management [22]. Thus the researcher has to pay emphasis in producing blast-resistant rice with lower ecotoxicity, eutrophication, carcinogenics and acidification impact [4]. Several scientific study have identified plant species with more than 2400 bioactive compounds having insecticidal and anti-pathogenic properties, commonly referred as 'green pesticides', which are more compatible with environmental components compared to synthetic pesticides [23].

In the present investigation leaf blast infections were more in 2013 compared to 2012. The yearly differences that occurred in blast infection levels were most likely due to the weather parameters. The year 2013 receives more rainfall in compare to 2012. The development of favorable conditions like high relative humidity and moderate temperature favors leaf blast infection [24] which was also observed during this investigation. The use of plant-derived products with azadiractin as principal constituent was tested to be successful in controlling rice leaf blast [25,26,27,28]. Spraying of commercial neem-based biopesticide increases height, number of tillers per plant and yield contribution factors such as percentage of productive spikelets, 100 grains of weight and grains yield per plant as compared to chemical pesticide [29]. Muralidharan *et al.* [30] observed that application of plant derived commercial products Achook, Neemazal, Neemgold and Wanis were found promising in reducing the severity of leaf blast up to 40 to 44% [30] which was also investigated in this study. Madhusudan (2004)

reported that Tricure followed by Neem Azal and Neemgold were significantly effective and were on par with fungicide Hinosan in controlling leaf blast of rice [17]. Tripathi *et al.* [31] observed that spraying of plant products Wanis, Achook and Neemgold along with standard chemical fungicide shows an effective reduction in leaf blast severity in rice [31]. Pandey [32] tested four leaf extract and observed that *A. indica* leaf extract was found most effective in suppressing mycelial growth of blast pathogen *in vitro* [32]. Sireesha (2013) observed that Neem seed kernel extract, was considered second best after *Pseudomonas flourescens* in controlling leaf blast and enhancing grain yield in rice [26].

Efficacy of various plant extract in controlling leaf blast and enhancing grain yield in rice were reported to be successful. Study on the efficacy of ten medicinal plants against rice blast fungus reported that the leaf extract of *Calotropis gigantia, Calendula officinalis, Achyranthus aspera, Eclipta alba, Ricinus communis* and *Moringa pterygosperma*, in desirable concentration were found most effective in minimizing radial growth of the pathogen [33]. Kavitha *et al.* [34] observed that application of sea weed extract during flowering and milk stages shows significantly higher growth and yield attributes along with higher grain yield [34]. Abed-Ashtiania *et al.* [35] reported that Plant Tonic9 (EOX-SOV) a natural product inhibits *M. oryzae* pathogen of rice *in vitro* and *in vivo* than fungicide propiconazole, and also enhances phenolic compounds accumulation and increases activity of peroxidase and polyphenol oxidase enzymes [35]. Application of leaf extracts of bael (*Aegle marmelos* Corr.) and tulasi (*Ocimum sanctum* L) along with the chemicals, showed effective results in reducing leaf blast severity, and enhancing number of grains per panicle, 1000-grain weight and grain yield in rice [36]. Hubert *et al.* [37] studied the efficacy of eleven plant extracts and reported that processed *C. arabica* had the highest inhibitory effect against *P. grisea* and all the tested extract did not show any phytotoxic effect on seed germination, seedling growth, seedling vigour index, root length, shoot height and dry weight of rice plant [37]. Shafaullah and Khan [38] tested nine botanical pesticides and observed that ginger and garlic, and chili and aak were found most effective in controlling leaf and neck blast of rice respectively [38]. Sukanya *et al.* [39] investigated two essential oils and one oleoresin and found that pepper oil was effective against *P. oryzae* pathogen [39]. Plant extract of rue (*Ruta graveolens*) has potentiality to suppress rice blast *in vitro*, as well as in greenhouse conditions without damaging cell wall and plasma membrane of the fungus [40]. Rajeswari and Mariappan tested eleven plant extract and reported that *Prosophis juliflora*, *Adhatoda vasica* and *Vitex negun* restricted the radial growth of *P. oryzae* amended in apple agar medium[41].

In the present work it was noted that application of commercial botanical products with principal constituent azadirachtin, a triterpenoid was effective in blast management. The neem product has potentiality to prevent germination of fungal spores and they do not seem to develop resistance in the pathogen they affect. The yield character also gave better response in the plot sprayed with plant products. The plant height was noticed to be remarkable when treated with biopesticides. The neem-based biopesticide shows positive effect on plant height resulting in crop growth and grain yield [22]. Similarly tiller and panicle number of the rice plant were also found promising with potentiality to influence grain yield. Plant height and tiller number are important character in improving grain yield in rice. As tillering also has a significant impact on number of panicle, so these three factors plays an important role in increasing grain yield in rice [22]. The treatment of botanicals was advantageous in improving grain weight and yield. This increase may be attributed to the number of tillers per plant which is expressed as a significant yield attributing character resulting in increasing number of 100 grain weight and crop yield [22]. The results concluded that applications of plant derived commercial products shows an effective management of rice blast for the growers. They significantly improve all yield characters which are effective in crop growth and grain yield. Moreover, applications of these products proved worth as they are economical, feasible and nature-friendly. More research is required to enhance ingredient composition and their disease combating mechanism. On-farm trials under changing weather conditions are recommended along with addition of some other natural product with synergetic effect.

Table 1: Effect of botanicals on leaf blast severity of rice

Treatments	Disease index (%)		Mean	Disease control (%)
	2012	2013		
Achook	20.2	41.9	31.05	36.63
Neem Azal T/S	20.4	42.1	31.3	36.12
Neem Gold	22.5	42.6	32.55	33.58
Spictaf	24.1	43.6	33.85	30.91
Tricure	23.3	42.8	32.7	33.27
Wanis	26.8	45.3	36.05	26.42
Biotos	25.4	52.2	38.8	20.81
Bavistin	14.8	39.3	27.05	44.79
Hinosan	17.5	40.8	29.15	40.51
Control	37.7	60.3	49	
SEm±	0.06	0.04		
CD(5%)	0.23	0.14		

Table 2: Effect of botanicals on yield attributes of rice

Treatment	Plant height (cm)			No. of tillers plant^{-1}			No. of spikelet panicle^{-1}			Panicle length (cm)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
Achook	93	116	104.5	16	17	16.5	165	169	167	23	25	24
Neem Azal T/S	92	113	102.5	16	16	16	165	168	166.5	23	25	24
Neemgold	90	112	101	14	15	14.5	165	167	166	22	26	24
Spictaf	88	110	99	13	15	14	155	158	156.5	22	24	23
Tricure	89	111	100	13	15	14	162	164	163	22	24	23
Wanis	87	107	97	12	14	13	155	158	156.5	21	24	22.5
Biotos	86	106	96	12	14	13	154	157	155.5	20	24	22
Bavistin	96	120	107.5	18	19	18.5	169	171	170	24	25	24.5
Hinosan	95	123	109.5	16	18	17	168	169	168.5	24	25	24.5
Control	85	103	94	12	13	12.5	151	153	152	22	21	21.5
SEM±	0.31	0.27		0.42	0.56		0.56	0.73		0.72	0.52	
CD (5%)	1.10	0.97		1.46	1.95		1.95	2.56		2.50	1.83	

Table 3: Effect of botanicals on yield and seed weight of rice

Treatment	Yield q ha^{-1}			Increase in yield (%)	100 Seed weight (g)			Increase in grain weight(%)
	2012	2013	Mean		2012	2013	Mean	
Achook	22.75	19.34	21.05	29.97	2.08	2.12	2.10	25
Neem Azal T/S	21.50	18.28	19.89	22.85	2.03	2.06	2.05	22.02
Neemgold	21.05	17.90	19.48	20.30	2.02	2.05	2.04	21.43
Spictaf	20.55	17.47	19.01	17.41	1.80	1.83	1.82	8.33
Tricure	20.80	17.68	19.24	18.82	1.97	2.01	1.99	18.46
Wanis	20.48	17.41	18.95	17.00	1.73	1.77	1.75	4.17
Biotos	19.80	16.83	18.32	13.10	1.68	1.72	1.70	1.2
Bavistin	24.50	20.83	22.67	39.99	2.23	2.30	2.27	35.12
Hinosan	23.60	20.06	20.83	34.81	2.17	2.23	2.20	30.96
Control	17.50	14.88	16.19		1.65	1.71	1.68	
SEM±	0.93	1.53	0.31		0.22	0.38		
CD (5%)	3.25	5.32	1.05		0.77	1.35		

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