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Evaluation of aqueous botanical extracts and bio-agents against biotic stresses in paddy

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Abstract

A field study was conducted during kharif 2011-12 and 2012-13 to study the efficacy of locally available weed plant species (*Datura stramonium*, *Calotropis gigantea*, *Nerium indicum* and *Azadirachta indica*) and bio-agents (*Trichoderma viride* and *Pseudomonas fluorescens*) against major pests (stem borer, gall midge and leaf folder) and diseases (sheath blight, sheath rot, leaf spots and false smut) prevalent in north coastal zone of Andhra Pradesh. Among the treatments, soil application of *Pseudomonas fluorescens* @ 2 kg/ac was found most effective in managing sheath blight incidence and promoting growth. Aqueous neem leaf extract @ 5 ml per liter was found statistically superior in managing stem borer incidence. However, none of the aqueous leaf extracts were found effective in minimizing false smut, gall midge and leaf folder. Soil application of *P. fluorescens* was the most effective recording 4624 kg/ha yield as against 4919 kg/ha in chemical treatment.

Keywords: Biotic stress, sheath blight, sheath rot, stem borer, *Pseudomonas fluorescens*, *Azadirachta indica*, IDM

Introduction

Rice (*Oryza sativa*) is a major food crop in Andhra Pradesh occupying more than 2.39 million hectares (2014-15) with a productivity of 3022 kg/ha (Ministry of Agriculture, 2015) [9]. During cultivation of paddy, a number of biotic and abiotic factors influence the yield. With governments focus on food security and farmers goal on maximizing yields, it is inevitable to go for intensive cultivation to meet the future food needs of our population. During recent years, there is tremendous reliance on pesticides for attaining food security. However, this comes with the cost of health, often residues of harmful pesticides in food. With increasing awareness among consumers on the ill effects of pesticides and growing demand to produce crops with minimal use of synthetic agrochemicals it is imperative to focus on growing crops with minimal crop residues. In this direction there is a need to look at cheap, safe and locally available resources for the management of pests and diseases. Among the biotic constraints limiting yields in paddy, sheath blight, blast, sheath rot, stem borer, BPH and leaf folder were significant in North coastal zone of Andhra Pradesh (Anonymous 2012) [3]. Previously, extracts obtained from a number of plant species have been found effective on plant pathogens both *in vitro* and *in vivo* (Ali *et al.*, 2007; Chaliganjewar *et al.*, 2010) [1, 5]. In some instances, botanical extracts were found to be equally effective to fungicides in management of diseases in crops (Lakhveer Singh *et al.*, 2011) [8]. In the present study, an effort was made to evaluate the efficacy of selected plant extracts which are commonly available as weeds in north coastal zone of Andhra Pradesh along with established bioagents (*Trichoderma viride* and *Pseudomonas fluorescens*) against major biotic stresses prevalent in the area.

Materials and methods

A field trial was conducted during *Kharif* for two years (2011-12 and 2012-13) at Agricultural Research Station, Ragolu, Srikakulam district, Andhra Pradesh. The trial was laid out in randomized block design with three replications adopting a plot size of 5.4 x 2.4 m and a spacing of 20 x 15 cm. Recommended dose of fertilizers (120-60-50 NPK kg/ha) was applied during the crop season. The experiment was conducted under irrigated dry conditions which are typical of North coastal zone of Andhra Pradesh. Test variety being Swarna (MTU 7029) was used for the present study.

Plant extract preparation

Common weed plant species available locally in north coastal zone of Andhra Pradesh with proven pesticidal activity were selected *viz.*, *Datura stramonium* (fruit), *Nerium indicum*, *Azadirachta indica* and *Calotropis gigantea* for studying their efficacy against biotic stresses in

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paddy. Selected plant parts were collected, cleaned of dust by washing in tap water, air dried and subsequently aqueous plant extracts were prepared by grinding equal amounts of plant part and sterile distilled water in a mixer grinder, filtered through muslin cloth before preparation of spray fluid. Treatment imposition of plant extracts was done @ 0.5%. Treatments were imposed for 4 times during the crop growth period at an interval of 10 days starting at 25 days after transplanting.

Application of bio-agents

For soil application, talc-based powder formulation of bioagents (*Trichoderma viride* – Biocure (F) and *Pseudomonas fluorescens* – Stanes Biocure-B of T Stanes and Company limited, Coimbatore) were incubated in 90 kg of completely decomposed FYM for 15 days before application to soil.

For foliar spray, talc-based formulation of the bio-control agents were prepared fresh and treatments were imposed @ 1%.

Data collection and analysis

Data on the incidence of diseases (sheath blight, sheath rot, leaf spots, grain discoloration and false smut) and insect pests (stem borer, gall midge and leaf folder) will be recorded at 15 days intervals from maximum tillering stage. Data on plant height (cm), number of tillers (no.) was recorded up to 10 days before harvest. Grain yield was recorded and expressed as kg/ha.

Results and discussion

The efficacy of locally available weed plant species (north coastal zone of Andhra Pradesh) was evaluated against pests

(stem borer, gall midge and leaf folder) and pathogens (sheath blight, sheath rot, leaf spots and false smut) prevalent in the area. During the study, pest and disease pattern varied with the season, comparatively more pest and disease incidence was recorded during 2011-12 compared to 2012-13. It is evident from the data (table 1) that none of the treatments were found effective in minimizing sheath blight and sheath rot incidence in paddy in comparison to the chemical treatment check, carbendazim spray. Chemical treatment (carbendazim) recorded 5.1 per cent mean sheath blight incidence followed by *Pseudomonas fluorescens* soil application (18.2%). Foliar spray of *P. fluorescens* @ 10 g/l was found effective in minimizing sheath rot and leaf spots incidence in paddy recording 9.3% and 4.2% incidence as against 3.3 and 2.4% respectively in chemical control. Although, foliar spray of *P. fluorescens* @ 10 g/l was found superior to botanical extracts, the treatment was found statistically at par with the same bioagent applied to soil. The efficacy of *Pseudomonas fluorescens* can be attributed to induction of bio-chemical defense mechanism in plants and its growth promoting ability by virtue of its ability to produce hormones (Sateesh *et al.*, 2004; Chaiharan *et al.*, 2009; Joe and Sivakumar 2010) [13, 4, 7]. Aqueous neem extract (leaf) was found marginally effective in minimizing sheath rot and leaf spot incidence in comparison to other aqueous plant extract treatments. The reduction in sheath rot incidence recorded in neem application could be attributed to the efficacy of neem against insect pests, which act as vectors or help in passive entry of sheath rot pathogen (Raja and Theradimani, 2010) [11]. In our study, *Trichoderma viride* strain used as foliar spray or soil application treatments did not show any positive influence in the management of diseases in paddy.

Table 1: Effect of aqueous plant extracts and antagonists on the development of diseases in paddy (2011-13)

S. No.	Treatment	Dose (g/lit)	Per cent Incidence								
			Sheath blight			Sheath rot			Leaf spots		
			2011-12	2012-13	Pooled Mean	2011-12	2012-13	Pooled Mean	2011-12	2012-13	Pooled Mean
1	<i>Datura stramonium</i>	5 ml	33.9 (35.6)*	20.7 (26.9)	27.3 (31.2)	15.2 (22.8)	9.9 (18.2)	12.6 (20.5)	7.1 (15.4)	2.0 (8.2)	4.6 (11.8)
2	<i>Calotropis gigantea</i>	5 ml	34.9 (36.2)	24.4 (29.5)	29.7 (32.8)	15.2 (22.9)	9.5 (17.9)	12.4 (20.4)	8.7 (17.1)	2.1 (8.3)	5.4 (12.7)
3	<i>Nerium indicum</i>	5 ml	33.2 (35.1)	27.4 (31.6)	30.3 (33.3)	21.7 (27.6)	9.8 (18.2)	15.8 (22.9)	8.7 (17.1)	2.1 (8.4)	5.4 (12.7)
4	<i>Azadirachta indica</i>	5 ml	34.9 (36.2)	26.2 (30.7)	30.6 (33.5)	14.2 (22.1)	8.8 (17.3)	11.5 (19.7)	6.8 (15.0)	1.8 (7.8)	4.3 (11.4)
5	<i>Trichoderma viride</i> (foliar)	10 g	32.9 (35.0)	25.3 (30.2)	29.1 (32.6)	12.5 (20.5)	11.2 (19.6)	11.9 (20.0)	8.1 (16.5)	2.0 (8.2)	5.1 (12.3)
6	<i>Trichoderma viride</i> (soil application)	1 kg/ ac	32.8 (34.8)	29.2 (32.7)	31.0 (33.7)	16.0 (23.5)	9.1 (17.6)	12.6 (20.5)	7.4 (15.7)	2.2 (8.5)	4.8 (12.1)
7	<i>Pseudomonas fluorescens</i> foliar	10 g	31.4 (34.0)	16.2 (23.7)	23.8 (28.0)	12.9 (24.5)	5.6 (13.3)	9.3 (18.9)	6.4 (14.7)	2.0 (8.2)	4.2 (11.4)
8	<i>Pseudomonas fluorescens</i> (soil application)	2 kg/ ac	27.9 (31.2)	8.4 (16.5)	18.2 (23.8)	17.7 (20.9)	6.4 (14.4)	12.1 (17.7)	9.8 (18.1)	1.3 (6.4)	5.6 (12.2)
9	Carbendazim	1 g	8.5 (16.9)	1.7 (7.5)	5.1 (12.2)	4.3 (11.9)	2.2 (8.5)	3.3 (10.2)	4.4 (12.0)	0.3 (3.1)	2.4 (7.6)
		CV	14.3	11.7	8.6	13.6	11.7	11.2	9.3	9.1	6.8
		CD	8.0	5.1	4.3	5.1	3.2	3.7	2.5	1.2	1.4

* Figures in parenthesis are arc sine transformed values

Table 2: Effect of botanicals and bio-agents on the incidence of seasonal pests and pathogens infecting paddy (2011-13)

S. No.	Treatment	Dose (g/l)	Stem borer incidence (%)			Seasonal pest/ pathogen incidence (%)		
						Gall midge	Leaf folder	False smut
			2011-12	2012-13	Pooled Mean	2011-12	2012-13	2012-13
1.	<i>Datura stramonium</i>	5 ml	12.0 (20.1)*	11.8 (20.1)	11.9 (20.1)	13.1 (21.2)	1.9 (7.9)	9.8 (18.2)
2.	<i>Calotropis gigantea</i>	5 ml	9.8 (18.1)	11.0 (19.1)	10.4 (18.6)	16.5 (23.9)	2.7 (9.3)	7.7 (15.9)
3.	<i>Nerium indicum</i>	5 ml	18.4 (25.4)	15.4 (23.1)	16.9 (24.2)	11.8 (20.1)	1.9 (7.6)	9.7 (18.1)
4.	<i>Azadirachta indica</i>	5 ml	9.3 (17.8)	5.2 (13.0)	7.3 (15.4)	10.6 (19.0)	1.5 (6.9)	7.9 (16.1)
5.	<i>Trichoderma viride</i> (foliar)	10 g	12.2 (20.1)	13.0 (20.9)	12.6 (20.5)	11.5 (19.8)	2.6 (9.2)	9.8 (17.8)
6.	<i>Trichoderma viride</i> (soil application)	2 kg/ ac	12.3 (20.5)	12.9 (20.9)	12.6 (20.7)	13.9 (21.8)	2.2 (8.5)	7.8 (16.0)
7.	<i>Pseudomonas fluorescens</i> foliar	10 g	12.9 (21.0)	13.7 (21.5)	15.3 (21.2)	12.1 (20.3)	2.0 (7.9)	8.2 (16.4)
8.	<i>Pseudomonas fluorescens</i> (soil application)	2 kg/ ac	12.7 (20.7)	13.4 (21.4)	13.1 (21.1)	12.2 (20.4)	2.2 (8.5)	7.2 (15.5)
9.	Carbendazim	1 g	12.4 (20.6)	10.4 (18.7)	11.4 (19.6)	12.0 (20.2)	2.1 (8.3)	1.7 (7.4)
		CV (%)	11.4	11.5	6.2	8.6	15.1	12.1
		CD (0.05)	4.0	1.3	2.1	3.1	0.7	1.1

* Figures in parenthesis are arc sine transformed values

Biotic stresses varied with the season, significant incidence of stem borer was recorded during the two years of study, however, natural incidence of gall midge could be recorded only during 2011-12 and leaf folder, and false smut during 2012-13, hence data pertaining to those years only was presented. *Azadiracta indica* aqueous leaf extract foliar spray @ 5 ml per liter was found statistically superior in both the years of study in reducing stem borer incidence. Stem borer incidence ranged from 7.3% (Neem leaf extract) - 16.9% (Nerium leaf extract). However, aqueous Nerium leaf extract was effective against gall midge with 10.6% incidence in comparison to *Calotropis* leaf extract which recorded 16.5% gall midge incidence. (table 2) Present findings are in agreement with Anaso (2010) [2] regarding the efficacy of neem pesticides on whorl larva, stem borer and panicle insect pests. The treatments evaluated did not influence the development of false smut in paddy. During the study, botanical extracts and bio-agents were also evaluated for their growth promoting ability, plant height

ranged from 103–111cm during 2011-12 and mean tiller number ranged from 11–12.3/hill. Although there is no significant difference among treatments (aqueous extracts and bio-agents) in promoting plant height and tiller number, *P. fluorescens* soil application treatment was found to have growth promoting effect (increasing plant height and increasing no. of tillers) in both the years. *P. fluorescence* soil application treatment recorded a maximum mean yield of 4624 kg/ha (pooled mean) among the plant extracts and bio-agents against 4919 kg/ha recorded in chemical control (table 3). Yield enhancing ability of *Pseudomonas* has been earlier attributed to reduction in disease and pest incidence as a result of enhancement of systemic resistance in plants (Vidhyasekaran *et al.*, 2001; Pathak *et al.*, 2004; Rajbir 2005; Duraisamy *et al.*, 2009) [14, 10, 12, 6]. Nerium leaf extract treatment was found to be least effective in promoting growth of paddy. The study suggests that periodic soil application of effective antagonists (*Pseudomonas fluorescens*) could effectively reduce diseases and enhance yields in paddy.

Table 3: Efficacy of aqueous botanical extracts and antagonist treatments on plant growth in paddy (2011-13)

S. No.	Treatment	Dose (g/l.)	Plant height (cm.)			No. of Tillers			Yield (Kg/ha)		
			2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean
1	<i>Datura stramonium</i>	5 ml	104.5	104.6	104.6	11.8	11.6	11.7	3874	4610	4242
2	<i>Calotropis gigantea</i>	5 ml	103.6	104.0	103.8	11.2	12.2	11.7	3785	4758	4272
3	<i>Nerium indicum</i>	5 ml	109.4	104.2	106.8	11.0	12.2	11.6	3644	4733	4189
4	<i>Azadirachta indica</i>	5 ml	109.9	104.4	107.2	11.5	11.7	11.6	3770	4812	4291
5	<i>Trichoderma viride</i> (foliar)	10 g	106.9	104.5	105.7	11.5	12.2	11.9	3837	4639	4238
6	<i>Trichoderma viride</i> (soil application)	2 kg/ ac	109.4	104.7	107.0	11.6	12.4	12.0	3800	4769	4284
7	<i>Pseudomonas fluorescens</i> foliar	10 g	106.0	104.5	105.3	11.7	12.0	11.0	3933	4859	4396
8	<i>Pseudomonas fluorescens</i> (soil application)	2 kg/ ac	111.0	106.2	108.6	11.9	12.7	12.3	4158	5173	4665
9	Carbendazim	1 g	110.7	104.5	107.6	11.2	11.8	11.5	4289	5548	4919
	CV		4.7	2.9	2.9	11.1	6.8	5.8	7.4	7.8	5.6
	CD		NS	NS	NS	NS	1.34	1.2	496	655	423

Conclusion

In our study, to evaluate the efficacy of locally available aqueous plant extracts and bio-agents against biotic stresses in paddy, soil application of *Pseudomonas fluorescens* @ 2 kg/ ac was found effective in managing sheath blight incidence in paddy in addition to promoting growth. Neem leaf extract @ 5 ml per liter was found statistically superior in managing stem borer incidence. However, none of the aqueous leaf extracts were found effective in minimizing false smut, gall midge and leaf folder. Periodical soil application of *P. fluorescens* was found to minimize disease incidence (Sheath blight) and promote yields in paddy.

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