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CONTENTS

Screening of different combinations of *Trichoderma harzanium and Pseudomonas fluorescens* for growth promotion activity in rice plants under glass house conditions

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ABSTRACT: *Oryza sativa* (Rice) is the member of family Poaceae which comprises 25 wild species of rice. The expected increase in population is about 77 million people per year and in coming 20 years the approximate demand of rice will increase about 2.5% per year. In present investigation the fungal and bacterial bio control agents i.e., *Trichoderma harzanium and Pseudomonas fluorescens* alone and in combination were tested for growth promotion activity in rice plants under glass house condition. The result of the study reveals that the effect of seed treatment, soil treatment and foliar sprays of biocontrol agents consortia PBAT3, followed by consortium of TH17+Pf173, on seed germination percentage, root-shoot length, dry weight and fresh weight of rice plant was found very effective as comparison to control.

Key words: Bioagents, PBAT3 *Pseudomonas*, rice, *Trichoderma*

Rice (*Oryza sativa*) is an staple food for most of the Indians and play a vital role in overall world grain production (Zibaee, 2013). Rice production system purposed to meet out the food grain requirement of increasing world population. The expected increase in population is about 77 million people per year and in coming 20 years the anticipated demand of rice will increase about 2.5% per year (Yellareddygari *et al.,* 2014). The highest production of rice is in West Bengal with 14.67 M tonnes followed by Uttar Pradesh with 12.509 M tonnes. District Udham Singh Nagar provide maximum production of rice (48%) from an area of 33% among all districts in Uttarakhand (Kabdwal *et al.*, 2022). Because of almost 3 billion people worldwide depends on rice as staple food crop and intake 50-80% of daily calorie from rice solely. Thus, increase the production and productivity of rice is must to meet out the global demand (Rice knowledge Management Portal, D. R. R.2013). Diseases are the major factors for reduction in crop yield of rice, according to Margani and Widadi (2018) there are number of pathogens cause heavy loss in rice. For the management of diseases farmers applied hazardous chemicals, which not only causes environmental pollution but also deteriorate the quality of rice. On the other hand in present scenario several microbial biological control agents emerge as a prominent and alternative tool not only in management of plant pathogens but also growth promoters of the plant (Kabdwal *et al.*, 2023). It is necessary to keep plants stronger to tolerate the attack of the pathogens. Keeping in view the importance of rice crop present investigation was planned with major emphasis on the use of fungal and bacterial bio control agents along with their suitable consortia to prove the efficacy of various combinations of fungal and bacterial Biocontrol agents for the growth promotion activity which leads to increasing crop productivity.

MATERIALS AND METHODS

In present investigation, was carried out in glasshouse of the Department of Plant Pathology at G.B. Pant University of Agriculture and Technology, Pantnagar during 2019-2020. For the experiment, the rice plants were raised in 20 cm diameter pots, having 2 kg capacity. The pot experiment was laid in completely randomized design (CRD) with three replications. Soil was autoclaved at 120^0C for 20 minutes for two consecutive days. In each pot, 6

seeds of ricevariety Pant Dhan 4 were sown. The pot experiment was conducted to test the efficacy of fungal (*Trichoderma harzanium*) and bacterial (*Pseudomonas fluorescens)* biocontrol agents in single and consortium to comparison with fungicide (carbendazim). Isolates of different biocontrol agent were obtained from the antagonists repository of biocontrol laboratory, department of plant Pathology College of agriculture, GBPUAT, Pantnagar are listed below.

1. PBAT-3 (*T. harzinium* + *Pseudomonas fluorescens*)
2. Th-14 (*T. harzanium*)
3. Th-17 (*T. harzanium*)
4. Psf-173 (*Pseudomonas fluorescens*)
5. Psf-2 (*Pseudomonas fluorescens*)

bacterial and fungal biocontrol agents formulated powder was used to know the effect of biocontrol agents in alone or in combinations on growth parameter and germination percentage. The colony forming units (CFU) of formulated powder of fungal bioagents was maintained at $2X10^6$ CFU/gm and for bacterial bioagent it was maintained at $1X10^8$CFU/gm.

Layout of pot experiment

The pot experiment was conducted to evaluate the efficacy of *Trichoderma harzinium* and *Pseudomonas fluorescens* isolates in single and in consortium. Completely randomized design (CRD) was applied to conduct experiment in pot. 11 treatments having 3 replications were used.

Treatment details

The following treatments were applied in pot experiment to evaluate the efficacy of these bio agents and their consortia: Th-17 + Pf-173; Th-17+ Pf-2; Th-17 + Th-14; Th-14+ Pf-2; Th-17; Th-14; Pf-2; Pf-173; PBAT-3; Carbendazim; Control

The method of application of biocontrol agents in different treatments was same for both bacterial (*Pseudomonas fluorescens*) and fungal (*Trichoderma harzanium*) bio control agents. Methods of application of biocontrol agents were: soil application, seed treatment and foliar spray. Soil treatment with biocontrol agents was done one week before sowing. For soil treatment 10gm biocontrol agents were mixed with 100gm of vermicompost to enhance the property of biocontrol agents. This mixture was applied in the soil after 1 week; thereafter the treated soil was filled in 2kg capacity pots.10gm of biocontrol agent formulation in single and in consortium were applied in 1kg of seed and after 24 hours of incubation, rice seedswere sown in pots. Six treated seed/pot were sown carrying with different treatment along with three replications. Foliar spray of biocontrol agents was done on the standing rice plants at 30 days after sowing @ 10gm in 1 litre of water.

The statistical analysis of pot house experiment data was examined by CRD (completely randomized design) with the help of OPSTAT software. The data found by OPSTAT were compared by means of critical difference at 5% level of significance.

RESULTS AND DISCUSSION

The results in 1 reveals that the highest seed germination percentage after 10 days of sowing was found in the consortium of PBAT3 (87%), followed by Th17+Pf173 (84.66%), carbendazim (81.83%), Th17+Pf2 (77.66%) and Th14+Pf2 (77.66%) which

Table 1: Effect of consortium of fungal and bacterial bioagents in rice seed germination percentage, root length and shoot length

Treatments	seed germination% (10 DAS)	Root length (cm)	Shoot length (cm)
Th17+Pf173	84.66	21.83	56.08
Th17+Pf2	77.66	21.50	55.31
Th17+Th14	73.50	19.66	51.45
Th14+Pf2	77.66	21.33	53.75
Th-17	77.66	18.00	53.66
Th-14	73.83	18.25	48.08
Pf-2	72.16	20.23	48.75
Pf-173	73.50	17.41	46.25
PBAT-3	87.00	22.08	56.25
Carbendazim	81.83	17.16	45.25
Control	61.00	15.08	38.40
C.D.	0.373	1.57	1.92
C.V.	4.780	4.76	2.24

Table 2: Effect of consortium of fungal and bacterial bioagents in rice fresh weight and dry weight of root and shoot under glasshouse condition

Treatments	Fresh weight of root (gm)	Fresh weight of shoot (gm)	Dry weight of root (gm)	Dry weight of shoot (gm)
Th17+Pf173	0.93	3.33	0.83	1.53
Th17+Pf2	0.93	3.32	0.73	1.48
Th17+Th14	0.88	2.36	0.61	0.64
Th14+Pf2	0.88	2.83	0.62	1.14
Th-17	0.80	2.34	0.53	0.56
Th-14	0.34	1.49	0.18	0.61
Pf-2	0.42	1.94	0.60	0.94
Pf-173	0.61	1.60	0.52	0.62
PBAT-3	0.94	3.38	0.84	1.62
Carbendazim	0.29	1.46	0.18	0.46
Control	0.20	1.04	0.15	0.36
C.D.	0.02	0.11	0.06	0.04
C.V.	1.73	2.89	6.34	2.52

were significantly better than the control (61%). The present results are also supported by the work of Kumar *et al.*(2012) and Xue (2003) who have also reported significant increase in seed germination of Pea by treatment with biocontrol agents consotium. seed germination was maximum (83 %) where *Pseudomonas* and *Trichoderma* alone and in combination was applied exhibited significant increase in germination over control. Mixed formulation differed from individual isolates with respect to its effect on seed germination in chickpea. Mixed formulation exhibited maximum seed germination (95 %) followed by PBAP-27 (93 %) and PBAT-43 (85%) Kumar and Garampalli (2013) results was similar with present investigation.

In case of plant length in glass house conditions, the

Fig. 1: Performance of biocontrol agent formulation in single and in consortiium in rice plant growth under Glass house conditons

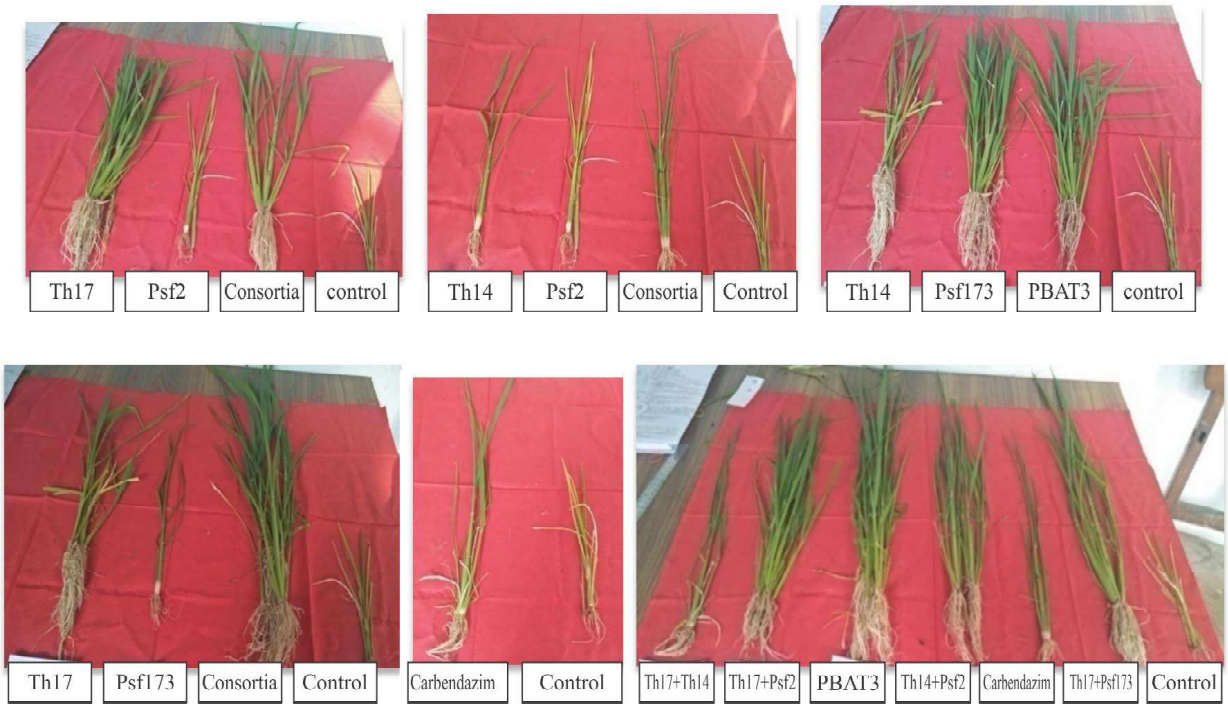

Fig. 2: Performance of biocontrol agent formulation in single and in consortiium on root and shoot length of rice plant under Glass house condition

effect of fungal and bacterial biocontrol agents PBAT3 showed highest root and shoot length. Maximum root length of rice plants was observed in treatment PBAT3 (22.08cm), followed by Th17+Psf173 (21.83cm), Th17+Psf2 (21.50cm) and Th14+Psf2 (21.33cm) which was significantly better than the carbendazim (17.16cm) and control (15.08cm). Shoot length in rice plant was also maximum in PBAT3 (56.25cm), folllowed by Th17+Pf173 (56.08cm), Th17+Pf2 (55.31cm) and Th14+Pf2 (53.75cm) which was significantly batter than the carbendazim (45.25cm) and control (38.40cm) (fig.1 and 2, Table 1).

The effect of different treatments of fungal and bacterial biocontrol agents in single and consortium application presented in Table 2 reveals that the maximum fresh weight of root was observed in PBAT3 (0.94g), followed by Th17+Pf173 (0.93g), Th17+Pf2 (0.93g) and Th14+Pf2 (0.88g).Maximum fresh weight of shoot was recorded in the consortium of PBAT3 (3.38g), followed by Th17+Pf173 (3.33g), Th17+Pf2 (3.32g) and Th14+Pf2 (2.83g).Maximum dry weight of roots was observed in PBAT3 (0.84g), followed by Th17+Pf173 (0.83g), Th17+Pf2 (0.73g) and Th14+Pf2 (0.62g).Maximum dry weight of shoot was observed in PBAT3 (1.62g), followed by Th17+Pf173 (1.53g), Th17+Pf2 (1.48g) and Th14+Pf2 (1.14g) all the treatments were significantly better than the carbendazim and control. A similar finding in reference to effect of biocontrol agents consortia on fresh weight and dry weight was also made in case of *R. japonicum* suspension to the soil contaminated by the two pathogens improved seed germination. Pandey and Maheshwari (2007) also found the similar result in case of *Cajanus cajan.*

CONCLUSION

The study revealed that the biocontrol agents consortia were best in the maximum seed germination, dry and fresh weight, root and shoot length. The performance of consortium of potential isolates of *Trichoderma* and *Pseudomonas* were effective for increase plant vigour. The result of the study reveals that the soil application and seed bio priming method through biocontrol agents is very effective in terms of plant growth promotion of rice

plants and this may be due to sequestration of nutrients from soil and other mode of actions like ISR. Thus, the results of study can be explored for the further study regarding plant growth promotion of rice plants under field condition and antagonistic potential of Biocontrol agents.

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