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Bio-efficacy of Thiophanate methyl 41.7% SC against Blast, Sheath rot, stem rot and Grain Discoloration diseases of Paddy

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Abstract
Paddy is an important food crop of the world including India. Under field condition, the productivity of rice is affected by many biotic and abiotic factors. Among the different biotic constraints, diseases caused by fungal pathogens such as blast and sheath rot, stem rot, grain discoloration are more frequent and ferocious disease in irrigated rice of both temperate and subtropical areas and which cause damage at all stages of crop growth. Blast, sheath rot, stem rot and grain discoloration are major constrain of paddy production reported to cause extensive damage in crop production. An experiment was conducted to assess the Bio- efficacy and Phytotoxicity of Thiophanate methyl 41.7% SC against blast, sheath rot, stem rot and grain discoloration diseases of Paddy at ARS, Gangavathi. Results revealed that, among the various treatments evaluated, Thiophanate methyl 41.7% SC @ 1200 ml/ha (T3) and Thiophanate methyl 41.7% SC @ 960 ml/ha (T2) were found to be the best treatments to control blast, sheath rot, stem rot and grain discoloration during both the seasons. The phyto- toxic effects such as leaf necrosis, leaf tip injury, wilting, vein clearing, epinasty and hyponasty were recorded on ten randomly selected plants of Rice from each plot at 3 and 5 days after application (DAA) and it was noticed that no phyto-toxicity were recorded with foliar application of Thiophanate methyl 41.7% SC at all the concentrations tested *i.e.* 1200, 1920 and 2400 ml/ha dose during both the seasons.

Keywords: Paddy, Blast, sheath rot, stem rot, grain discoloration, bio-efficacy, phytotoxicity, Thiophanate methyl 41.7% SC

Introduction
Rice (*Oryza sativa* L.) is an important food crop of the world including India. Ever growing population in the world particularly in India is further demanding more rice production and continuous reduction in the availability of cultivable land demanding higher productivity. Under field condition, the productivity of rice is affected by many biotic and abiotic factors. Among the different biotic constraints, diseases caused by fungal pathogens such as blast and sheath rot, stem rot, grain discoloration are more frequent and ferocious disease in irrigated rice of both temperate and subtropical areas and which cause damage at all stages of crop growth. Rice blast caused by *Pyricularia oryzae* Cavara [synonym *Pyricularia grisea* Sacc. the anamorph of *Magnaporthe grisea* (Herbert) Yaegashi and Udagawa], is one of the most destructive and wide spread disease of rice [Jia *et al*., 2000] [4]. Blast epidemic causes the complete defeat of seedling [Chaudhary *et al*., 1994] at the nursery and in field condition [Teng 1991] [11] and causes up to 80% of total yield reduction [Koutroubas *et al*., 2009]. Sheath rot, caused by *Sarocladium oryzae*, and stem rot caused by *Sclerotium oryzae* are important destructive disease of rice occurs in all rice growing areas of the world. In India, a modest estimation of losses due to the sheath rot disease alone has been up to 54.3% [Rajan *et al*., 1987] [9]. The disease is particularly important in intensive rice production systems due to excess use of nitrogenous fertilizers. The grains are infected by various organisms *viz*., *Drechslera oryzae, D. rostratum, Curvularia lunata, Sarocladiu oryzae, Alternaria tenuis, Fusarium moniliforme, Cladosporium herbarum*, *Phoma* sp. and *Nigrospora* sp. before or after harvesting causing discoloration. The infection may be external or internal causing discoloration of the glumes or kernels or both causing both quantitative and qualitative losses of grains. Dark brown or black spots appear on the grains causing red, yellow, orange, pink or black discoloration depending upon the organism involved and the degree of infection (TNAU agri portal).

Materials and Method

Blast, Sheath rot, stem rot and Grain Discoloration are major constrain of paddy production reported to cause extensive damage in crop production. Therefore, an effective management of crop is required from early stage of diseases development which can be assured by proper fungicides.

A. Bio-efficacy

The fungicides were applied as foliar spray treatment in the replicated plots just after the appearance of Blast, Sheath rot and stem rot diseases in the main field and standard agronomic practices were adopted for the *Kharif* 2017-18 cultivation season. The plots were inspected regularly to see the disease development and further two more spray were applied at an interval of 7 days.

To know the effect of Thiophanate methyl 41.7% SC on the Blast, Sheath rot, stem rot and Grain Discoloration of rice crop observation for disease incidence were recorded from the randomly selected ten hills per plot and efficacy of molecule in controlling of these diseases. Observation were recorded on the basis of scoring of the diseases as per the disease rating scale of SES, IRRI, (2002).

Observation on intensity of diseases were observed in each replicated plot for each treatment and per cent disease incidence were calculated based on following formula.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of numerical rating}}{\text{Total no. of plants observed X Maximum rating scale}} \times 100$$

In order to record the yield, crop was harvested from the individual replicated plots and average paddy yield was recorded and expressed as q/ha.

Experiment details

Location	:	ARS Gangavathi
Season	:	*Kharif*
Year	:	2017-18
Crop	:	Rice
Variety	:	BPT-5204
Soil type	:	Black clay
Irrigated/Rainfed	:	Irrigated
Date of sowing	:	08.08.2017 (*Kharif*); 03.12.2017 (*Summer*)
Date of Transplanting	:	06.09.2017 (*Kharif*); 02.01.2018 (*Summer*)
Application method	:	Foliar spray
No. of applications	:	Three at 7 days interval
Growth stage/Age of the crop at the time of application	:	Milky stage

Treatment Details

a. Bio-efficacy study

Tr. No	Treatment	Dosage per ha		Dilution in water (Liters)
		a.i. (g/ml)	Formulation (g/ml)/ha	
T1	Thiophanate methyl 41.7% SC	300	720	500
T2	Thiophanate methyl 41.7% SC	400	960	500
T3	Thiophanate methyl 41.7% SC	500	1200	500
T4	Tricyclazole75%WP	225	300	500
T5	Hexaconazole 75% WG	50	66.7	500
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	500
T7	Untreated Control	Water spray	Water spray	500

Results and Discussion

a. Bio-efficacy: Blast disease

Among the vaious treatments evaluated, Thiophanate methyl 41.7% SC @ 1200 ml/ha (T3) and Thiophanate methyl 41.7% SC @ 960 ml/ha (T2) were found to be the best treatments during both the seasons as they recorded 4.40 PDI and 5.98 PDI as compared to 29.84 PDI in untreated control at terminal observation during *Kharif* 2017-18 (Table 1b); 6.67 PDI and 8.83 PDI as compared to 36.89 PDI in untreated control at terminal observation during *Summer* 2017-18, for leaf blast disease (Table 1b). Thiophanate methyl 41.7% SC @ 1200 ml/ha and Thiophanate methyl 41.7% SC @ 960 ml/ha recorded its superiority in both the seasons during all the observation days. The effect of foliar treatment on blast disease control with Thiophanate methyl 41.7% SC @ 1200 ml/ha and Thiophanate methyl 41.7% SC @ 960 ml/ha were statistically on par with each other during both the seasons. The next best treatment in reducing the blast disease was Tricyclozole 75% WP with incidence of 9.00 PDI during *Kharif* 2017-18, 14.12 PDI during *Summer* 2017-18.

Sheath rot disease

Lowest sheath rot disease intensity of 6.00 per cent during *Kharif* 2017-18 (Table 2a) and 4.67 per cent during *Rabi Summer* 2017-18 (Table 2b) was recorded in the treatment of Thiophanate methyl 41.7% SC @ 1200 ml/ha insignificantly followed by in Thiophanate methyl 41.7% SC @ 960/ha which recorded disease intensity of 7.69 per cent during *Kharif* 2017-18 and 5.33 per cent during *Rabi Summer* 2017-18. Both these treatments were found significantly superior to rest of the treatments and provided higher reduction in disease incidence. Hexaconazole 75% WG @ 66.7g/ha recorded disease intensity of 7.86 per cent during *Kharif* 2017-18 and 5.33 per cent during *Rabi Summer* 2017-18 which followed above treatments and provided at par disease intensity. Control treatment exhibited disease intensity of 26.40 per cent during *Kharif* 2017-18 and 22.78 per cent during *Rabi Summer* 2017-18.

Stem rot disease

Lowest stem rot disease intensity of 7.34 per cent during *Kharif* 2017-18 (Table 3a) and 6.46 per cent during *Rabi Summer* 2017-18 (Table 3b) was recorded in the treatment of Thiophanate methyl 41.7% SC @ 1200 ml/ha insignificantly followed by in Thiophanate methyl 41.7% SC @ 960/ha which recorded disease intensity of 10.50 per cent during *Kharif* 2017-18 and 6.63 per cent during *Rabi Summer* 2017-18. Both these treatments were found significantly superior to rest of the treatments and provided higher reduction in disease incidence. Hexaconazole 75% WG @ 66.7g/ha recorded disease intensity of 10.98 per cent during *Kharif* 2017-18 and 7.03 per cent during *Rabi Summer* 2017-18 which followed above treatments and provided at par disease intensity. Control treatment exhibited disease intensity of 32.96 per cent

during *Kharif* 2017-18 and 28.56 per cent during *Rabi Summer* 2017-18.

Grain discoloration

The treatments Thiophanate methyl 41.7% SC @ 1200 ml/ha and Thiophanate methyl 41.7% SC @ 960 ml/ha were recorded lower grain discolouration and found to be the best treatments as there were 5.25 PDI and 5.88 PDI in rice recorded during *Kharif* 2017-18 (Table 4a); 3.79 PDI and 4.33 PDI in rice recorded during *Rabi Summer* 2017-18 (Table 4b) respectively, as compared to 30.34 PDI during *Kharif* 2017-18 and 26.40 PDI in untreated control during *Rabi Summer* 2017-18. Several fungicides in solo formulation such as Benomyl, Edifenphos, Thiophanate Methyl, Propiconozole have been reported to be effective in reducing stem rot disease under field condition (Singh *et al.*, 2002; Gopika *et al.*, 2016) [10, 3]. Similarly, Bhuvaneshwari & Raju, 2012 reported the better efficacy of combination fungicide azoxystrobin 18.2% + difenoconazole 11.4% SC (strobilurin + triazole) against sheath blight disease. Various experimental reports confirmed that strobilurin compounds (either solo or in combination) found to be effective in controlling many rice diseases like grain discoloration, blast, sheath rot and brown spot (Pramesh *et al*., 2016) [8].

Rice yield

During *Kharif* 2017-18 result showed that highest paddy yield (Table 4a) was obtained from the treatment with Thiophanate methyl 41.7% SC @ 1200 ml/ha i.e. 64.90 q/ha was also at par with Thiophanate methyl 41.7% SC @ 960 ml/ha recorded 63.30 q/ha of paddy yield. All the treatments were significantly superior with respect to control (Table 4a). Minimum paddy yield *i.e*. 37.50 q/ha was recorded on untreated control treatment.

During *Rabi Summer* 2017-18 results showed that highest paddy yield (Table 4b) was obtained from the treatment with Thiophanate methyl 41.7% SC @ 1200 ml/ha i.e. 70.10 q/ha was also at par with Thiophanate methyl 41.7% SC @ 960 ml/ha recorded 68.30 q/ha of paddy yield. All the treatments were significantly superior with respect to control (Table 4b). Minimum paddy yield *i.e.* 44.80 q/ha was recorded on untreated control treatment.

Present results are in conformity with those of previous publication where, fungicides application increases the yield of rice (Tirmali *et al.*, 2001; Prabhu *et al.*, 2003, Usman *et al.*, 2009; Naik *et al.*, 2012; Bhuvaneshwari and Raju, 2012; Bag *et al.*, 2016; Pramesh *et al.*, 2016) [12, 7, 13, 6, 2, 1 8]. The increased yield is mainly due to reduced disease severity of stem rot disease of rice.

Table 1a: Efficacy of Thiophanate methyl 41.7% SC on blast disease incidence of Rice during *Kharif* 2017-18 (1st Season)

	Treatment	Dosage per Formulation			Percent Disease Index (PDI)		
Sl. No.		a.i. (g/ml)		Before	7 days after	7 days after	7 days after
			(g/ml)/ha	1st spray	1st spray	2nd spray	3rd spray
T1	Thiophanate methyl 41.7% SC	300	720	1.11 (6.06)	3.52 (10.83)	6.12 (14.14)	9.00 (17.50)
T2	Thiophanate methyl 41.7% SC	400	960	1.89 (7.92)	2.54 (9.19)	4.29 (11.97)	5.98 (14.16)
T3	Thiophanate methyl 41.7% SC	500	1200	1.77 (7.66)	2.17 (8.49)	3.52 (10.83)	4.40 (12.11)
T4	Tricyclazole75%WP	225	300	1.81 (7.75)	4.11 (11.70)	9.00 (17.50)	12.18 (20.42)
T5	Hexaconazole 75% WG	50	66.7	1.27 (6.49)	6.04 (14.24)	11.10 (19.48)	14.12 (22.07)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	1.62 (7.33)	7.33 (15.72)	13.89 (21.90)	16.33 (23.85)
T7	Untreated Control	Water spray	Water spray	1.03 (5.84)	17.10 (24.43)	28.99 (32.59)	29.84 (33.12)
	CD (0.05)			NS	0.67	1.71	2.08

*Data in the parenthesis is angular transformed value

Table 1b: Efficacy of Thiophanate methyl 41.7% SC on blast disease incidence of Rice during *Summer* 2017-18 (2nd Season)

Sl. No.	Treatment	Dosage per ha		Percent Disease Index (PDI)			
		a.i. (g/ml)	Formulation/(g/ml)ha	Before	7 days after	7 days after	7 days after
				1st spray	1st spray	2nd spray	3rd spray
T1	Thiophanate methyl 41.7% SC	300	720	3.52(10.83)	7.22(15.55)	8.56(16.95)	12.58(20.77)
T2	Thiophanate methyl 41.7% SC	400	960	4.29(11.97)	5.89(13.97)	7.22(15.55)	8.83 (17.29)
T3	Thiophanate methyl 41.7% SC	500	1200	3.42(10.67)	4.89(12.72)	5.45(13.46)	6.67 (14.97)
T4	Tricyclazole75%WP	225	300	3.78(11.23)	9.55(17.96)	12.44(20.55)	14.12(22.07)
T5	Hexaconazole 75% WG	50	66.7	3.41(10.66)	11.44(19.70)	16.33(23.83)	18.33(25.35)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	3.33(10.52)	13.67(21.67)	17.89(24.93)	23.45(28.96)
T7	Untreated Control	Water spray	Water spray	3.20(10.21)	16.67(24.10)	26.78(31.16)	36.89(37.37)
	CD (0.05)				NS	1.51 0.91	1.31

*Data in the parenthesis is angular transformed value

Table 2a: Efficacy of Thiophanate methyl 41.7% SC on sheath rot disease incidence of Rice during *Kharif* 2017-18 (1st Season)

Sl. No	Treatment	Dosage per			Percent Disease Index (PDI)		
		a.i. (g/ml) ha	Formulation (g/ml)/ha	before	7 days after 1st	7 days after	7 days after 3rd
				1st spray	spray	2nd spray	spray
T1	Thiophanate methyl 41.7% SC	300	720	3.33 (10.53)	8.65 (17.12)	11.10 (19.48)	13.34 (21.43)
T2	Thiophanate methyl 41.7% SC	400	960	3.26 (10.42)	5.25 (13.26)	6.02 (14.22)	7.69 (16.12)
T3	Thiophanate methyl 41.7% SC	500	1200	3.67 (11.06)	4.67 (12.47)	5.54 (13.63)	6.00 (14.18)
T4	Tricyclazole75%WP	225	300	2.95 (9.91)	11.25 (19.62)	17.22 (24.54)	19.12 (25.94)
T5	Hexaconazole 75% WG	50	66.7	3.87 (11.36)	5.33 (13.35)	6.04 (14.24)	7.86 (16.30)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	3.42 (10.67)	8.98 (17.46)	11.47 (19.81)	13.89 (21.90)
T7	Untreated Control	Water spray	Water spray	3.20 (10.31)	13.69 (21.73)	19.54 (26.25)	26.40 (30.94)
	CD (0.05)			NS	0.86	1.66	2.19

*Data in the parenthesis is angular transformed value

Table 2b: Efficacy of Thiophanate methyl 41.7% SC on sheath rot disease incidence of Rice during *Summer* 2017-18 (2nd Season)

Sr. No	Treatment	Dosage per		Percent Disease Index (PDI)			
		a.i. ha	Formulation (g/ml)/ha	before 1stspray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray
T1	Thiophanate methyl 41.7% SC	300	720	0.67(4.71)	4.67(12.49)	7.17(15.55)	8.98(17.46)
T2	Thiophanate methyl 41.7% SC	400	960	0.63(4.57)	2.95(9.91)	4.73(12.58)	5.33(13.35)
T3	Thiophanate methyl 41.7% SC	500	1200	1.03(5.84)	2.01(8.17)	3.45(10.72)	4.67(12.47)
T4	Tricyclazole75%WP	225	300	1.11(6.06)	8.32(16.78)	15.14(22.91)	18.25(25.29)
T5	Hexaconazole 75% WG	50	66.7	1.27(6.49)	2.84(9.72)	4.67(12.49)	5.33(13.35)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	1.02(5.81)	5.25(13.26)	8.67(17.14)	11.33(19.67)
T7	Untreated Control	Water spray	Water spray	0.54(4.23)	11.65(19.98)	17.36(24.64)	22.78(28.38)
	CD (0.05)			NS	0.82	1.19	1.61

*Data in the parenthesis is angular transformed value

Table 3a: Efficacy of Thiophanate methyl 41.7% SC on stem rot disease incidence of Rice during *Kharif* 2017-18 (1st Season)

Sl. No	Treatment	Dosage per		Percent Disease Index (PDI)			
		a.i. (g/ml) ha	Formulation (g/ml)/ha	before 1stspray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray
T1	Thiophanate methyl 41.7% SC	300	720	3.98 (11.51)	8.65 (17.12)	12.05 (20.33)	15.27 (23.01)
T2	Thiophanate methyl 41.7% SC	400	960	4.40 (12.11	7.03 (15.39)	10.00 (18.45)	10.50 (18.93)
T3	Thiophanate methyl 41.7% SC	500	1200	3.87 (11.36)	5.54 (13.63)	7.03 (15.39)	7.34 (15.74)
T4	Tricyclazole75%WP	225	300	4.11 (11.70)	13.89 (21.90)	19.12 (25.94)	21.78 (27.82)
T5	Hexaconazole 75% WG	50	66.7	4.00 (11.50)	7.34 (15.74)	10.43 (18.86)	10.98 (19.37)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	4.23 (11.87)	9.40 (17.87)	13.34 (21.44)	15.27 (23.01)
T7	Untreated Control	Water spray	Water spray	3.60 (10.94)	19.54 (26.25)	26.40 (30.94)	32.96 (34.80)
	CD (0.05)			NS	1.03	0.82	1.51

*Data in the parenthesis is angular transformed value

Table 3b: Efficacy of Thiophanate methyl 41.7% SC on stem rot disease incidence of Rice during *summer* 2017-18 (2nd Season)

Sl. No	Treatment	Dosage per		Percent Disease Index (PDI)			
		a.i. (g/ml) ha	Formulation (g/ml)/ha	before 1stspray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray
T1	Thiophanate methyl 41.7% SC	300	720	2.33(8.85)	7.22 (15.55)	8.33(16.76)	10.43 (18.86)
T2	Thiophanate methyl 41.7% SC	400	960	3.33(10.52)	4.54 (12.32)	5.44(13.44)	6.63 (14.94)
T3	Thiophanate methyl 41.7% SC	500	1200	3.20(10.31)	4.44 (12.13)	5.00(12.92)	6.46 (14.74)
T4	Tricyclazole75%WP	225	300	3.24(10.38)	13.67 (21.67)	16.33(23.83)	19.54 (26.25)
T5	Hexaconazole 75% WG	50	66.7	2.69(9.46)	5.45 (13.46)	5.89(13.97)	7.03 (15.39)
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	2.98(9.96)	9.55 (17.96)	11.44(19.70)	13.89 (21.90)
T7	Untreated Control	Water spray	Water spray	2.54(9.19)	15.74 (23.37)	23.45(28.96)	28.56 (32.23)
	CD (0.05)			NS	1.24	1.32	2.13

*Data in the parenthesis is angular transformed value

Table 4a: Efficacy of Thiophanate methyl 41.7% SC on grain discolouration and yield of Paddy during *Kharif* 2017-18 (1st Season)

Sl. No	Treatment	Dosage per		Grain discolouration (PDI)	Yield (q/ha)
		a.i. (g/ml) ha	Formulation (g/ml)/ha		
T1	Thiophanate methyl 41.7% SC	300	720	9.45 (17.90)	57.20
T2	Thiophanate methyl 41.7% SC	400	960	5.88 (14.05)	63.30
T3	Thiophanate methyl 41.7% SC	500	1200	5.25 (13.26)	64.90
T4	Tricyclazole75%WP	225	300	17.36 (24.62)	45.80
T5	Hexaconazole 75% WG	50	66.7	7.37 (15.74)	62.20
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	14.12 (22.07)	48.20
T7	Untreated Control	Water spray	Water spray	30.34 (33.44)	37.50
	CD (0.05)			1.19	2.17

*Data in the parenthesis is angular transformed value

Table 4b: Efficacy of Thiophanate methyl 41.7% SC on grain discolouration and yield of Paddy during *Summer* 2017-18 (2nd Season)

Sr. No	Treatment	Dosage per		Grain discolouration (PDI)	Yield (q/ha)
		a.i. (g/ml)ha	Formulation (g/ml)/ha		
T1	Thiophanate methyl 41.7% SC	300	720	6.36 (14.63)	64.90
T2	Thiophanate methyl 41.7% SC	400	960	4.33 (12.01)	68.30
T3	Thiophanate methyl 41.7% SC	500	1200	3.79 (11.23)	70.10
T4	Tricyclazole75%WP	225	300	14.12 (22.09)	47.80
T5	Hexaconazole 75% WG	50	66.7	5.25 (13.25)	67.30
T6	Hexaconazole 4% + Zineb 68% WP	(40 + 680)	1000	11.10 (19.48)	50.10
T7	Untreated Control	Water spray	Water spray	26.40 (30.94)	44.80
	CD (0.05)			1.52	2.45

*Data in the parenthesis is angular transformed value

Conclusion

The foliar application of Thiophanate methyl 41.7% SC @ 960 to 1200 ml/ha were effective in control of Blast, Sheath rot, stem rot and Grain Discoloration and resulting higher yield of rice. Thiophanate methyl 41.7% SC @ 960 ml/ha and Thiophanate methyl 41.7% SC @ 1200 ml/ha were found on par at all the observation days. Hence, considering the efficacy and economics of fungicide use it can be concluded that Thiophanate methyl 41.7% SC @ 1200 ml/ha is effective in managing the blast diseases of rice without any harmful effect on crop.

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