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Role of resistance inducing chemicals against soybean dry root rot (*R. bataticola*) disease

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Abstract
All of the test ISR chemicals, applied as seed treatment and foliar spray (alone and in combination) and the standard check fungicide Carbendanzim 50 % WP seed treatment @ 1g/kg seed were found to reduce significantly soybean dry root rot incidence, over untreated control. However, the most effective treatment found was Salicylic acid ST + it's FS, with significantly highest reduction in average mortality (92.90%), followed by Chitosan ST + it's FS (89.34 %), Salicylic acid ST (86.88%), β-amino butyric acid ST + it's FS (85.89%), Chitosan ST (82.63%), β-amino butyric acid ST (80.64%), Jasmonic acid ST + it's FS (77.62%) and Jasmonic acid ST (72.85%) and Carbendazim (53.16 %).

Keywords: Salicylic acid, chitosan, *R. bataticola*

Introduction
Soybean [*Glycine max* (L.) Merril] is a major commodity traded in world markets and currently, the world's prime oilseed crop (Sonka *et al.*, 2004) [9]. However, there are several reasons for low productivity of soybean, of which the diseases caused by a large number of fungal, bacterial and viral pathogens are the major constraints. During recent past, the soybean crop has badly been affected by the pathogenic fungus *Rhizoctonia bataticola* (Tabb.) Butler, causing dry root rot disease. Dry root rot disease (*R. bataticola* = *M. phaseolina*), which was previously supposed to be minor disease of soybean and other crops, but now has emerged as major threat. The pathogen *R. bataticola* has been reported to incur potential seed yield losses in the range of 3-36 % (Sangeetha and Jahagirdar, 2013a) [5] and even upto 77 per cent (Muthusamy and Mariappan, 1991) [4]. In Marathwada region, soybean crop is being grown on large area and the dry root rot / charcoal rot disease has been found to be quite severe. *R. bataticola,* being mostly soil borne, wider adaptability and long term survivability in soil, makes difficult to control it with chemicals alone, which also seems to be non-feasible, uneconomical and hazardous to the ecosystem. Hence, it is imperative to exploit alternative and eco-friendly disease management practices for sustainable agriculture.

Materials and Methods
The black coloured nursery polybags (20 x 30 cm.) culture experiment was conducted under controlled conditions of screen house during, *Kharif* 2016-17, to evaluate the efficacy of ISR chemicals / elicitors against *R. bataticola,* the incitant of soybean dry root rot.
A total of four ISR chemicals / elicitors were evaluated as pre-sowing seed treatment and a single foliar spray at 21 days after sowing (alone and in combinations) against *R. bataticola,* by sick soil method. ISR chemicals / elicitors pre-treated seeds of susceptible soybean Cv. MAUS-162 were sown (10 seeds / bag) in these polybags containing sick soil / potting mixture. Two bags / treatment / replication were maintained. Surface sterilized healthy seeds of soybean Cv. MAUS-162 sown (10 seeds / bag) in *R. bataticola* sick soil containing bags, without any chemical treatment were maintained as untreated control (absolute check). The soybean Cv. MAUS-162 seeds treated with Carbendazim @1 g/kg seed and sown in the polybags containing sick soil / potting mixture were maintained as standard check.
Observations on pre-emergence seed rot (PRESR) and post-emergence seedling mortality (POESM) were recorded, respectively at 7-8 days and 15 and 30 days after sowing and total mortality was computed. Per cent PRESR, POESM and total mortality were calculated by applying following formulae:

$$\text{PRESR (\%)} = \frac{\text{No. of Seeds un-germinated}}{\text{Total no. of Seeds sown}} \times 100$$

$$\text{POESM (\%)} = \frac{\text{No. of Seedlings died}}{\text{Total no. of Seedlings}} \times 100$$

$$\text{Total mortality (\%)} = \text{PRESR} + \text{POESM}$$

Further, per cent reduction in total mortality with the treatments, over untreated control (sick soil alone) was calculated by following formula:

$$\text{\% Disease control} = \frac{C - T}{C} \times 100$$

Where,
C = Total mortality in untreated control
T = Total mortality in treatment

Results and Discussion

Average mortality recorded (PLATE I, Table 1 and Fig. 1) with the ISR chemicals treatments ranged from 5.84 to 22.12 per cent, as against 36.38 per cent in standard check (Carbendazim ST) and 81.00 per cent in standard check (untreated control). However, it was significantly least with Salicylic acid ST + it's FS (5.84 %), followed by Chitosan ST + it's FS (8.61 %), Salicylic acid ST (10.77 %), β-amino butyric acid ST + it's FS (11.67 %), Chitosan ST (14.25 %), β-amino butyric acid ST (15.17 %), Jasmonic acid ST + it's FS (18.25 %) and Jasmonic acid ST (22.12 %).

Plate 1: Efficacy of ISR chemicals / elicitors against soybean dry root rot (Cv. MAUS-162)

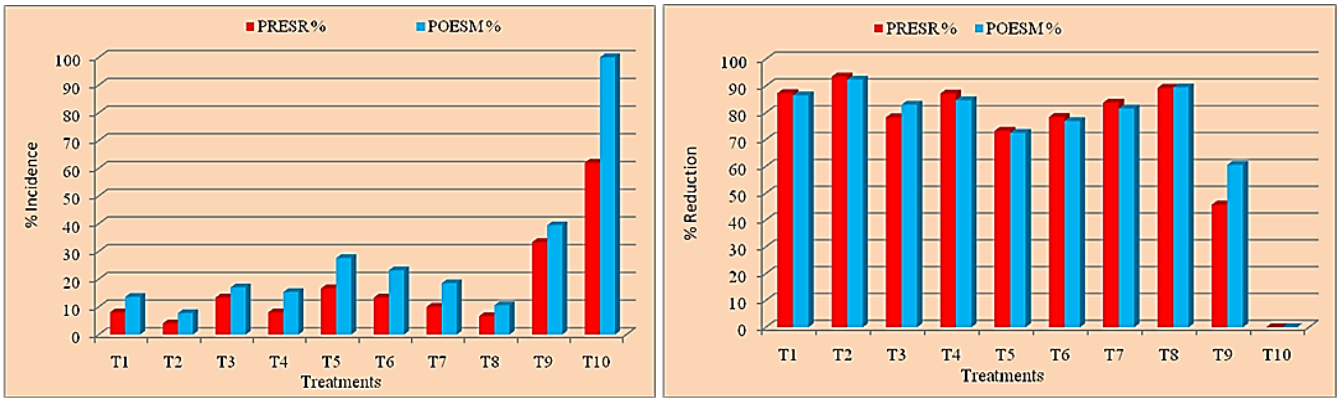

Fig 1: Efficacy of various ISR chemicals / elicitors against soybean dry root rot

The most effective treatment found was Salicylic acid ST + it's FS, with significantly highest reduction in PRESR (93.47 %), POESM (92.32 %) and their average reduction (92.90 %). This was followed by Chitosan ST + it's FS (89.24 %, 89.44 % and 89.34 %), Salicylic acid ST (87.29 %, 86.46 % and 86.88 %), β-amino butyric acid ST + it's FS (87.11 %, 84.66 % and 85.89 %), Chitosan ST (83.76 %, 81.51 % and 82.63 %), β-amino butyric acid ST (78.29 %, 83.00 % and 80.64 %), Jasmonic acid ST + it's FS (78.40 %, 76.84 % and 77.62 %) and Jasmonic acid ST (73.28 %, 72.42 % and 72.85 %) and Carbendazim (45.74 %, 60.58 % and 53.16 %), over untreated absolute check.

Thus, the ISR elicitors / chemicals *viz.*, Salicylic acid, β-amino butyric acid, Jasmonic acid and Chitosan, evaluated in present study suggested that these could induced systemic resistance in soybean, so as to reduce mortality caused due to *R. bataticola* in soybean. But, field efficacy of these ISR elicitors against *R. bataticola* needs to be confirmed.

These results are also inconsonance with the reports of earlier workers such as Singh and Dwivedi (1987) [8] who reported salicylic acid, picric acid and 2, 4-dinitrophenol as effective against *S. rolfsii;* Dantre *et al.* (2003) [3] reported acetyl salicylic acid, amino isobutyric acid, IAA, DL- beta amino-butyric acid and salicylic acid as effective against *R. solani;* Sarwar *et al.* (2005 and 2010) [6, 7] reported salicylic acid (1.0 & 1.5 mM) and Bion (0.3& 0.4mM) applied as seed treatment resulted with significant reduction in chickpea wilt (*F. oxysporum* f. sp. *ciceri);* Amini (2015) [1] reported *viz.*, Acibenzolar-S-methyl (ASM) and Chitosan when applied as foliar spray (each @ 100 µg ai/plant, significantly reduce verticillium wilt (*V. dahlia)* of potato and Chavan (2017) [2] evaluated in pot culture the ISR elicitors Chitosan, Salicylic acid and β-amino butyric acid applied as rhizome treatment + soil and reported all three as most effectiv in reducing Turmeric seedling mortality as will as rhizome rot caused by *P. aphanidematum.*

Table 1: Efficay of ISR elicitor/ chemicals against soybean dry root rot, caused by *R. bataticola* (pot culture)

Tr. No.	Treatments	Dosages (µM / kg seed or lit. water)	Incidence (%) *		Av. Mor. (%)	Red. (%) over control		Av. Red. (%)
			PRESR	POESM		PRESR	POESM	
T_1	Salicylic acid ST	1.5 µM	8.00 (16.43)	13.54 (21.59)	10.77 (19.16)	87.29 (69.12)	86.46 (68.41)	86.88 (68.76)
T_2	Salicylic acid ST + it's FS	1.5 µ M + 10 µM	4.00 (11.54)	7.68 (16.09)	5.84 (13.98)	93.47 (75.20)	92.32 (73.91)	92.90 (74.54)
T_3	β-amino butyric acid ST	30µM	13.33 (21.42)	17.00 (24.35)	15.17 (22.92)	78.29 (62.23)	83.00 (65.65)	80.64 (63.90)
T_4	β-amino butyric acid ST+ it's FS	30µM + 50 µM	8.00 (16.43)	15.34 (23.06)	11.67 (19.98)	87.11 (68.96)	84.66 (66.94)	85.89 (67.93)
T_5	Jasmonic acid ST	1.5 µM	16.67 (24.09)	27.58 (31.68)	22.12 (28.06)	73.28 (58.88)	72.42 (58.32)	72.85 (58.60)
T_6	Jasmonic acid ST + it's FS	1.5 µM + 20 µM	13.33 (21.42)	23.16 (28.77)	18.25 (25.29)	78.40 (62.31)	76.84 (61.23)	77.62 (61.77)
T_7	Chitosan ST	30µM	10.00 (18.43)	18.49 (25.47)	14.25 (22.18)	83.76 (66.24)	81.51 (64.53)	82.63 (65.37)
T_8	Chitosan ST + it's FS	30 µM + 50 µM	6.67 (14.96)	10.56 (18.96)	8.61 (17.07)	89.24 (70.85)	89.44 (71.04)	89.34 (70.94)
T_9	Carbendazim 50 % WP (ST) (Standard check)	@ 1 g/kg	33.33 (35.26)	39.42 (38.89)	36.38 (37.10)	45.74 (42.56)	60.58 (51.11)	53.16 (46.81)
T_{10}	Untreated Control (Absolute check)	--	62.00 (51.94)	100.00 (90.00)	81.00 (64.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SE ±		2.42	1.37	1.90	3.31	1.37	2.34
	CD (P=0.01)		7.11	4.02	5.57	9.73	4.02	6.88

*-Mean of three replications, Figures in parentheses are arcsine transformed values,
Av.: Average, Mor.: Concentration, Incr.: Increase Red.: Reduction, PRESR: Pre emergence seed rot, POESM: Post Emergence Seedling Mortality, ST: Seed Treatment, FS: Foliar Spraying

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