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MANAGEMENT OF SETT ROT [*CERATOCYSTIS PARADOXA* (DE SEYNES) MOREAU] IN SUSTAINABLE SUGARCANE INITIATIVE (SSI) NURSERIES

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ABSTRACT

Healthy sugarcane seedling production in Sustainable Sugarcane Initiative (SSI) is hindered by the incidence of sett rot *Ceratocystis paradoxa*(De Seynes) Moreau which causes 90% loss of seedlings. Among the different treatment combinations, bud chip treatment with *Pseudomonas fluorescens*@ 10 g/l+ *Trichoderma viride* @ 4 g/l+ mixing of *P. fluorescens*@ 1kg/250kg of coco peat and bud chip treatment with *P. fluorescens*@ 10 g/l followed by 0.1% thiophanatemethyltreatment were found to be highly effective with the germination percentage of 88 and 85 during south west monsoon and 83 and 81 during north east monsoon season respectively.Sett rot incidence in the above treatments was 15.5 and 13% during south west monsoon and 22.5 and 16.00% during north east monsoon respectively. The bud chip treatment with carbendazim and thiophanate methyl recorded 64 and 67% germination during south west and 62 and 61% during north east monsoon seasons. Economic analysis of management modules showed that 1.87 and 1.78 benefit cost ratio for *P. fluorescens* + *T. viride* combination and 1.84 and 1.83 benefit cost ratio for *P. fluorescens* + thiophanatemethyl combination during south west and north east monsoon season respectively.The results revealed that the combination of biocontrol agents can be effectively used for the management of sett rot in sugarcane nurseries.

INTRODUCTION

Sugarcane is being cultivated in 5 million hectares in India. Even though the Indian sugarcane area is second largest in the world, the production has been widely fluctuating between 233 and 385 million tonnes in the last 10 years. The productivity is between 65 - 70 tonnes/ha in the same period. Sustainable Sugarcane Initiative (SSI) is a novel method and being introduced with a package of practices for increasing the productivity. Among the various steps, raising seedlings using bud chips from sugarcane in the shade net nurseries is the foremost and important step in the SSI method of cultivation. The healthy seedlings from the shadenet will ensure uniform establishment and better crop stand in the main field.

In SSI nurseries the healthy seedling production is hindered by the incidence of sett rot caused by the pathogen *Ceratocystis paradoxa*(De Seynes) Moreau. It affects the germination of buds in the planting material. The sett rot fungus is present in all sugarcane growing soils and multiplies on any organic matter. It can enter through the end of the sett or damaged part of the sett. When the damaged setts are split, they smell like an over ripened pineapple. Hence it is called as pine apple disease. The odour is due to the methyl acetate formed by the metabolic activity of the pathogen. The ethyl content in the infected tissue may rise up to 1% that is sufficient to inhibit the germination of the buds (Kuo *et al*., 1969). Sett rot incidence is severe in the heavy textured soils and poorly drained fields and it can reduce the germination up to 47% (Agnihotri, 1983).Yadahalli *et al*. (2007) noticed 99.96% sett rot incidence in inoculated sterilized soils and 76.19 % incidence in the unsterilized soils.

In the sustainable sugarcane initiative (SSI) method, the bud chips were used to raise the seedlings. The bud chips were cut from the seven month old seed cane using hand operated bud chip cutting machine. The bud chips were treated with 0.1% carbendazim and 0.2% malathion to avoid the disease and insect pest problems in the nursery and they were placed in the seedling trays. The trays were kept in a shadenet house and covered with polythene sheet to induce germination.The incidence of sett rot mostly occurs 5 -7 days after keeping the buds in the seedling trays. The infected buds were failed to germinate in the trays.Farmers are of the opinion that 80% loss of seedling production occurs during rainy seasons mostly due to the sett rot incidence. The farmer's practice of bud chip treatment with 0.1% carbendazim was unable to provide complete control over the sett rot incidence in the nurseries.

Yadahalli *et al*., 2006 revealed that the chemical, biological and cultural management strategies in conjunction will give better control than following these methods separately. The sugarcane sett treatment with *Trichoderma viride* and *Pseudomonas fluorescens* along with organic amendments increased the sugarcane yield (Joshi, 1999). In the present investigation to manage the germination failure due to sett rot incidence in the sugarcane nurseries the biocontrol agents along with the other components and fungicides were evaluated.

MATERIALS AND METHODS

Sett rot management modules were evaluated during 2013-14 in the farmer's seedling production shadenet nurseries in four villages namely Poonianur, Odasalpatti, Papparapatty and Marandahalli of Dharmapuri district. These villages represent four blocks of the district and come under two different sugarmill operational areas. In these areas the loss due to settrot was up to 80% and hence these areas were selected for the present study. The management modules were evaluated in the south west and north east monsoon season to study the impact of rainfall and other weather parameters on the incidence of sett rot in sugarcane nurseries. The treatment combinations *viz*., bud chip treatment with 0.1% carbendazim 50WP (T1), bud chip treatment with *Pseudomonas fluorescens*@ 10g/L + *Trichoderma viride* @ 4 g/L + mixing of *P. fluorescens*@ 1kg/250kg of coco peat (T2), bud chip treatment with *P. fluorescens*@ 10 g/L followed by treatment using 0.1% thiophanate methyl 70% WP (T3), bud chip treatment with 0.2% thiophanate methyl 70% WP (T4) and untreated control (T5) were evaluated in the farmer's seedling production units. The dosages are based on Tamil Nadu Agricultural University, Coimbatore and Sugarcane Breeding Institute, Coimbatore recommendations.

The TNAU formulation of *P. fluorescens* and *T. viride*, Roko 70% WP from BIOSTADT for thiophanate methyl and Bavistin 50% WP from BASF for carbendazimwas used in the present study.As per the treatments, the bud chips were treated with above biocontrol agents and fungicides for 10-15 minutes. Then the bud chips were subjected for 0.2%Malathion treatment to avoid any insect incidence during the germination. The treated buds were placed in the 50 cell seedling trays filled with well decomposed coco peat. The seedling trays were stacked inside the shadenet house and covered with plastic covers to induce the germination of buds. After a week the covers were removed, the trays were placed side by side and watering was done using the flowerpot. The same procedure was followed in all the four locations (Anonymous, 2012).

The above treatments were replicated four times in all the locations. Observations on germination percentage and percentage of disease incidence were recorded at weekly interval from the 7^{th} day onwards and continued upto 30^{th} day. The un-germinated buds and stunted seedlings were removed from the seedling trays and the sett rot incidence was recorded by split opening the buds.The damage was expressed as per cent sett rot incidence to the total number of buds planted. The economics of different modules were computed on the basis of current labour cost, cost of inputs and market rate of seedlings. The data was subjected to analysis of variance using SPSS 16.0 statistical package. The least square difference (LSD) test was used to determine the significance between the treatments (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results of the present investigation were given in Table 1 and 2. Among the treatment combinations, the bud chip treatment with *P. fluorescens*+ *T. viride* and mixing of *P. fluorescens* along with coco peat (T2) and bud chip treatment with *P. fluorescens* followed by 0.1% thiophanate methyl treatment (T3) were found to be highly effective in managing the sett rot incidence in SSI nurseries. The treatment T2 recorded 88 and 83% germination during south west and north east monsoon seasons, respectively. It was followed by T3 and recorded the germination of 85 and 81% germination respectively (Table 1). During south west monsoon T2 and T3 recorded 15.50 and 13.00% sett rot incidence after first week in bud chip nursery. In the same season the treatments T2 and T3 recorded 8.50 and 8.00% sett rot incidence after fourth week in the shade net nursery. During north east monsoon season, T2 and T3 recorded 22.5 and 16.00% disease incidence in the first week and 14.00 and 7.50% disease incidence after fourth week in the shade net nursery (Table 2).

Viswanathan, (2009) revealed that *Pseudomonas* spp. strains were found to induce systemic resistance in sugarcane and will persist upto 90 days. He also found that the *Pseudomonas* and thiophanate methyl combination able to give 75% survival against red rot upto 150 days of planting. Malathi *et al*. (2002) revealed that the thiophanate methyl and *P. fluorescens* combination provided 87.67% plant survival in pot culture experiments. Talukder *et al*. (2007) observed that setts treated with *T. harzianum* recorded 14.83 - 20.33% higher germination compared to control. Mahalingam *et al*. (2011) found that different *Trichoderma* spp. reduced the pineapple disease incidence up to 75%. The findings of present study are also in agreement with the above findings. Joshi, (1999) recorded increased quantitative and qualitative yield after treating sugarcane setts with *T. viride* along with soil application of FYM @ 10t/ha and pressmud @ 25t/ha. Yadahalli *et al*. (2006) found that sett treatment with carbendazim @ 0.1% and *T. harzianum* @ 10 g/L along with soil application of FYM @ 25

Table 1: Effect different management module on the germination of sugarcane bud chips in the nurseries

Modules	South West Monsoon*				North East Monsoon*			
	I week	II week	III week	IV week	I week	II week	III week	IV week
T1	77.00 ^{c}(49.11)	71.50 ^{c}(46.21)	67.50 ^{b}(44.23)	64.00 ^{d}(42.23)	77.00 ^{c}(49.11)	72.00 ^{b}(46.46)	67.00 ^{c}(43.97)	62.00 ^{b}(41.60)
T2	92.50 ^{b}(59.70)	89.00 ^{a}(56.65)	88.50 ^{a}(56.35)	88.00 ^{a}(55.89)	94.00 ^{a}(62.35)	90.00 ^{a}(57.32)	85.00 ^{a}(53.80)	83.00 ^{a}(52.60)
T3	95.00^{a}(61.79)	90.50 ^{a}(57.87)	87.50 ^{a}(55.60)	85.00 ^{b}(53.86)	95.00 ^{a}(61.79)	88.50 ^{a}(56.34)	85.50 ^{a}(54.23)	81.00 ^{a}(51.38)
T4	77.00 ^{c}(49.08)	74.00 ^{b}(47.78)	68.00 ^{b}(44.45)	67.00 ^{c}(44.10)	79.00 ^{b}(50.19)	74.00 ^{b}(47.48)	70.00 ^{b}(45.48)	61.00 ^{b}(41.16)
T5	60.50 ^{d}(51.16)	53.00 ^{d}(46.74)	43.00 ^{d}(40.92)	33.50 ^{e}(35.26)	58.00 ^{d}(49.61)	50.00 ^{c}(45.00)	43.00 ^{d}(40.92)	35.00 ^{c}(36.17)
SEM	2.61	2.45	3.05	3.00	1.83	1.73	2.46	3.33
CD(0.05)	8.05	7.68	9.40	9.25	5.65	5.35	7.58	10.58

* Values are the mean of four locations; Figures in parentheses are arc sine transformed values; Figures followed by the same letter did not differ significantly

Table 2: Effect different management module on the sett rot incidence in the sugarcane bud chip nurseries

Modules	South West Monsoon*				North East Monsoon*			
	I week	II week	III week	IV week	I week	II week	III week	IV week
T1	34.00 d(28.52)	31.50c(27.30)	30.50 d(26.79)	27.00c(25.01)	34.00 d(28.53)	30.00 d(26.55)	30.00 d(26.55)	25.50 d(24.25)
T2	15.50 b(18.41)	11.50 a(15.68)	10.00 b(14.44)	8.50 a(13.41)	22.50 b(22.65)	16.00 b(18.81)	16.00 b(18.81)	14.00 b(17.47)
T3	13.00 a(16.78)	11.00 a(15.34)	11.00 a(15.34)	8.00 a(12.90)	16.00 a(18.79)	12.00 a(16.04)	11.00 a(15.42)	7.50 a(12.48)
T4	30.50 c(26.79)	27.50 b(25.27)	26.50 c(21.73)	25.50 b(24.23)	31.00 c(27.06)	27.50 c(25.29)	25.00 c(24.22)	22.90 c(22.29)
T5	53.00 e(46.73)	48.50 d(44.13)	47.50 e(43.55)	42.00 d(40.35)	58.00 e(49.61)	55.00 e(48.16)	50.25 e(45.14)	45.25 e(42.27)
SEM	2.45	2.16	1.79	2.62	1.09	1.26	1.67	1.62
CD(0.05)	7.56	6.65	5.53	8.08	3.37	3.90	2.36	5.01

* Values are the mean of four locations; Figures in parentheses are arc sine transformed values; Figures followed by the same letter did not differ significantly

Table 3: Effect different management module on the economics of sugarcane seedling production (for 12,500 seedlings)

Modules	South West Monsoon				North East Monsoon			
	Percent decrease over control*	Plant Protection cost (Rs)	Net Return (Rs)**	BCR	Per cent decrease over control*	Plant Protection cost (Rs)	Net Return (Rs)**	BCR
T1	35.79	1250	6700	1.50	42.31	1250	6560	1.48
T2	73.79	750	9360	1.87	66.35	750	8790	1.78
T3	77.89	1000	9180	1.84	77.88	1000	9080	1.83
T4	42.11	1250	7050	1.54	48.08	1250	7100	1.55
T5	-	-	4850	1.32	-	-	4550	1.29

* Mean of four locations; ** The average market cost is Rs.1.50/seedling

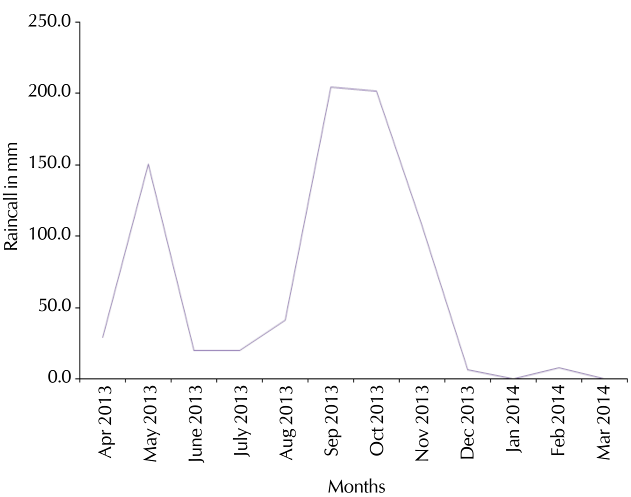

Figure 1: Rainfall statistics of Dharmapuri district for 2013-14

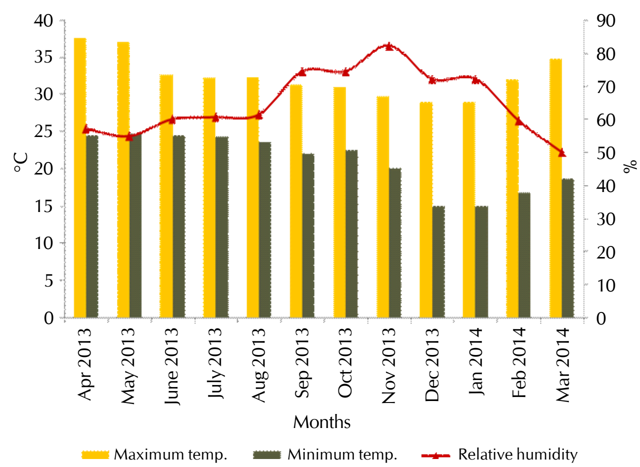

Figure 2: Temperature and Relative humidity statistics of Dharmapuri district for 2013-14

t/ha and vermicompost @ 2.5 t/ha reduced the sett rot incidence significantly and improved the quantitative and qualitative yield of sugarcane.

The carbendazim (T1) and thiophanate methyl (T4) bud chip treatments recorded 64 and 67% germination during south west monsoon and 62 and 61% during north east monsoon season, respectively (Table 1). The carbendazim (T1) and thiophanate methyl (T4) recorded 25.50 and 22.90% sett rot incidence during north east and 27 and 25.50% incidence during south west monsoon season in the fourth week (Table 2).The sett treatment with propiconazole (Raid *et al*., 1991) and carbendazim (Natarajan *et al*., 1991) effectively managed the sett rot incidence. Carbendazim completely inhibited the mycelialgowth of sugarcane red rot fungus compare to tebuconazole, propiconozole and hexoconozole (Bhardwaj and Sahu, 2014).Talukder *et al*. (2007) reported that the setts treated with *T. harzianum* and Bavastin 0.1% did not differ significantly regarding the germination percentage of the setts. Vijaya *et al*. (2007) revealed that systemic fungicides were highly effective in controlling the sett rot pathogen than that of non-systemic fungicides. In the present study the chemical fungicides able to offer 70% protection against the sett rot fungus in the nurseries.

The results indicated that the higher germination percentage was recorded in the south west monsoon than thenorth east monsoon season and the sett rot incidence was vice versa in both the seasons. The benefit cost analysis presented in Table 3 also revealed that the treatments T2 and T3 are highly effective with the higher BC ratio. Even though the study area received almost equal amount of rainfall in both the monsoon seasons (Fig. 1), the temperature difference between the seasons was higher (Fig. 2). During January,the average minimum temperature recorded in Dharmapuri district was 19ºC (Balachandran, 2009). The minimum temperature and higher relative humidity prevailing during October to January (Fig. 2) might have favoured the disease incidence which ultimately hindered the seedling production. In Dharmapuri district cane season starts during December. More disease incidence in the same period leads to economic loss to the seedling growers. Provision of proper drainage and maintenance optimum moisture inside the shade net will also reduce the sett rot incidence. According to Yadahalli *et al*. (2007), 60% soil moisture found to be optimum to reduce the incidence of sett rot. As the favourable weather conditions causes 100% loss in seedling production the combination of biocontrol agents can be effectively used by the seedling growers to protect from sett rot incidence and quality seedling production.

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