Doi: HTTPS://DOI.ORG/10.23910/IJBSM/2017.8.4.1816a

Evaluation of Organic Amendments Against *Ralstonia solanacearum* Causing Bacterial Wilt in Ginger

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Article History

Article ID: AR1816a
Received in 3rd June, 2017
Received in revised form 25th July, 2017
Accepted in 5th August, 2017

Abstract

The present field study was undertaken to investigate the effective organic amendments against *Ralstonia solanacearum* under pot culture condition. The average (PESR+PESM) reduction in mortality recorded with all the organic amendments tested were ranged from 15.39 to 64.97% over untreated control. However, significantly highest reduction in average mortality was recorded with karanj cake (64.97%). This was followed by the organic amendments viz., neem seed cake (43.95%), farm yard manure (37.36%), vermicompost (32.95%), poultry manure (32.24%) and sunflower seed cake (26.87%). Whereas, safflower seed cake (21.40%), goat manure (19.28%), cotton seed cake (18.60%) and groundnut cake (15.39%) were found less effective. All the test amendments improve root length, shoot length and vigour index in ginger. Among the different amendments tested, significantly highest root length (6.16 cm), shoot length (12.56 cm) and vigour index (1372.73) were recorded with Karanj cake. The second best amendment found was neem seed cake (5.26 cm, 10.26 cm and 931.20) respectively. This was followed by the amendments viz., farm yard manure (4.76 cm, 8.83 cm and 679.50), vermicompost (4.25 cm, 8.23 cm and 582.44), poultry manure (4.23 cm, 6.56 cm and 467.53), sunflower seed cake (4.08 cm, 6.13 cm and 374.40), safflower seed cake (3.66 cm, 5.96 cm and 352.76) for root length, shoot length and vigour index respectively.

Keywords: Ginger mortality, organic amendments, *Ralstonia solanacearum*, growth parameter

1. Introduction

India is considered as a *"magical land of spices"*. No other country in the world has such a diverse variety of spice crops as India. Ginger *(Zingiber officinale* Roscoe) a very useful herb plant, is said to be originated from India, China and Java. It is grown throughout the tropical areas of the world and also commonly found in South East Asia especially in Indo Malaysia. The crop suffers from diseases like bacterial wilt caused by *Ralstonia solanacearum*, rhizome rot caused by *Pythium* spp., *Fusarium* spp., *Sclerotium* spp., *Pseudomonas* spp. and others (Dake and Edison, 1989; Senapati and Ghose, 2005; Paret et al., 2010; Sharma et al., 2010; Kavyashree, 2011). Out of the above mentioned diseases of ginger, Ginger production is curtailed by bacterial wilt, one of the most destructive diseases of the crop in tropical agriculture (Hayward, 1990). Sambasivam and Girija (2005) reported host resistant and loss in ginger cultivation by *R. solanacearum* in Kerala. Many times this important cash crop is subjected to premature wilting resulting in 100% crop loss. Bacterial wilt, caused by *Ralstonia solanacearum* formerly known as *Pseudomonas solanacearum* (Smith) is one of the most serious soil-borne disease (Hayward, 2000). Bacterial wilt disease was widely distributed in tropical, subtropical and warm temperate regions of the world with a host range of 44 plant families (Hayward, 1991; Poussier et al., 1999; Kumar et al., 2004). Sharma and Jain (1978) identified that causal agent of bacterial wilt of ginger *is Ralstonia solanacearum* (Smith) Yabuuchi, biotype III. *R. solanacearum* causing wilt disease is one of the major constraints of ginger in small and marginal farming communities. The strain causing bacterial wilt of ginger in India belongs either to biovar 3 or 4; the former being the most virulent in India (Kumar and Sarma, 2004; Kumar and Hayward, 2005). The characteristic symptoms of bacterial wilt of ginger include green leaves roll and curl due to water stress caused by bacteria blocking the water-conducting vascular system of the ginger stems, leaf yellowing and necrosis (Nelson, 2013; White et al., 2013).

The aim of present investigation was to study the effect of organic inputs on growth of *Ralstonia solanacearum* and management of wilt disease of ginger under glass house conditions.

2. Materials and Methods

The present field study was undertaken at Department of Plant Pathology, College of Agriculture, Vasantarao Naik Marathwada Krishi Vidyapeeth, Parbhani during August 2014 to June, 2015 to investigate the effective organic amendments against *Ralstonia solanacearum* under pot culture condition. The experiment was laid in Complete Randomized Design (CRD) and imposed following treatments with three replications under each of them. To conduct the study a total of 10 organic amendments viz., FYM, poultry manure, neem seed cake, sunflower seed cake, vermicompost, cotton seed cake, karanj cake, goat manure, groundnut cake and safflower seed cake were evaluated against *R. solanacearum* by sick soil method in pot culture under screen house conditions. Except vermicompost, all the test amendments were crushed physically to rough powder and used for soil application.

The earthen pots (30 cm dia.) disinfected with 5% solution of Copper sulphate were filled with autoclaved potting mixture of soil:sand:FYM (2:1:1). The mass multiplied (48 hr old nutrient broth culture: 2×10^8 cfu ml^{-1}) of *R solanacearum* was drenched (@ 50 ml kg^{-1} potting mixture) evenly to the potting mixture in pots, these pots were incubated for 96 hrs in screen house to proliferate the bacterium and make the soil/potting mixture sick.

The coarse ground test amendments were applied (@ 50 g kg^{-1} mixture) in the earthen pots containing test bacterium sick soil/potting mixture, mixed thoroughly, watered regularly and maintained in screen house. After 72 hrs of amendments application, surface sterilized (0.1% $HgCl_2$) healthy rhizome of ginger were sown (10 rhizomes pot^{-1}), watered regularly and maintained in the screen house. Three pots/treatment/replication were maintained. The earthen pots containing *R. solanacearum* sick soil and sown with surface sterilized healthy rhizome of ginger, without amendment were maintained as untreated control. The percentage seed germination, pre-emergence seed rot, post-emergence seedling mortality and vigour index were calculated.

3. Results and Discussion

A total of 10 amendments were evaluated as pre-sowing soil application to assess their efficacy against *R. solanacearum*, employing sick soil technique and sowing susceptible ginger local variety in pot culture under glass house conditions.

3.1. Effect of seed germination and mortality

Results (Table 1) revealed that all the test amendments recorded significantly improved rhizome germination, over untreated control and it was ranged from 30.00 to 73.33%, as against 20.00% in untreated control. However, significantly highest rhizome germination was recorded with karanj cake (73.33). This was followed by the amendments viz., neem seed cake (60.00%), farm yard manure (50.00%), vermicompost (46.67%), poultry manure (43.33%), sunflower seed cake and safflower seed cake (each 36.67%). Whereas, cotton seed cake, goat manure (each 33.33%) and groundnut cake (30.00%) were found least effective with comparatively

Table 1: Effect of organic amendment on pre-emergence rhizome rot and post emergence seedling mortality caused by *R. solanacearum* in ginger

Tr. No.	Germination (%)	Rot/ mortality (%)*		Average mortality (%)	Reduction over control (%)		Average reduction (%)
		PESR	PESM		PESR	PESM	
T_1	50.00 (45.00)	50.00 (45.00)	54.33 (47.48)	52.16 (46.23)	37.50 (37.76)	37.22 (37.59)	37.36 (37.67)
T_2	43.33 (41.16)	56.66 (48.82)	55.67 (48.25)	56.16 (48.53)	29.16 (32.68)	35.32 (36.46)	32.24 (34.59)
T_3	60.00 (50.76)	40.00 (39.23)	53.66 (47.09)	46.83 (43.18)	50.00 (45.00)	37.91 (38.00)	43.95 (41.52)
T_4	36.67 (37.26)	63.33 (52.73)	58.00 (49.60)	60.66 (51.15)	20.83 (27.15)	32.91 (35.00)	26.87 (31.22)
T_5	46.67 (43.09)	53.33 (46.90)	58.33 (49.79)	55.83 (48.340	33.33 (35.26)	32.58 (34.80)	32.95 (35.03)
T_6	33.33 (35.26)	66.66 (54.73)	68.66 (55.95)	67.66 (55.34)	16.66 (24.08)	20.55 (26.95)	18.60 (25.54)
T_7	73.33 (58.90)	26.67 (31.09)	31.66 (34.24)	29.16 (32.68)	66.66 (54.73)	63.28 (52.70)	64.97 (53.71)
T_8	33.33 (35.26)	66.67 (54.73)	67.50 (55.24)	67.08 (54.98)	16.66 (24.08)	21.91 (27.90)	19.28 (26.04)
T_9	30.00 (33.21)	70.00 (56.78)	70.66 (57.20)	70.33 (56.99)	12.50 (20.70)	18.28 (25.31)	15.39 (23.09)
T_{10}	36.67 (37.26)	63.33 (52.73)	67.33 (55.13)	65.33 (53.92)	20.83 (27.15	21.98 (27.95)	21.40 (27.55)
T_{11}	20.00 (26.56)	80.00 (63.43)	86.66 (68.57)	83.33 (65.90)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SEm±	2.66	3.18	2.44	2.81	3.35	3.11	3.23
CD (*p*=0.01)	7.80	9.32	7.14	8.23	9.83	9.12	9.47

T_1: FYM; T_2: Poultry manure; T_3: Neem seed cake; T_4: Sunflower cake; T_5: Vermicompost; T_6: Cotton seed cake; T_7: Karanj cake; T_8: Goat manure; T_9: Groundnut cake; T_{10}: Safflower cake; T_{11}: Control (Untreated); *-Mean of three replications; Figures in parentheses are angular transformed values

minimum rhizome germination.

All the organic amendments applied in sick soil (*R. solanacearum*) were found effective against *R. solanacearum* and recorded pre-emergence seed rot in the range of 26.67 to 70.00% as against 80.00% in untreated control. However, significantly least pre-emergence seed rot was recorded with the amendment karanj cake (26.67%). This was followed by the amendment viz., neem seed cake (40.00%), farm yard manure (50.00%), vermicompost (53.33%), poultry manure (56.66%), sunflower seed cake and safflower seed cake (each 63.33%). Whereas, cotton seed cake, goat manure (each 66.66 %) and groundnut cake (70.00%) were found less effective (Figure 1).

Figure 1: Effect of organic amendments against R. *solanacearum*

All the organic amendments tested were found effective against *R. solanacearum* and recorded post-emergence seedling mortality in the range of 31.66 to 70.66% as against 86.66% in untreated control. However, significantly least pre-emergence seedling mortality was recorded with the amendment karanj cake (31.66%). This was followed by neem seed cake (53.66%), farm yard manure (54.33%), poultry manure (55.67%), sunflower seed cake (58.00%) and vermicompost (58.33%). Whereas, safflower seed cake (67.33%) goat manure (67.50%), cotton seed cake (68.66%), groundnut cake (70.66%), were found less effective.

The average mortality (PESR+PESM) recorded with all the treatments were ranged from 29.16 to 70.33% as against 83.33% in untreated control. However, significantly least average mortality was recorded with the amendment karanj cake (29.16%). This was followed by neem seed cake (46.83%), farm yard manure (52.16%), vermicompost (55.83%), poultry manure (56.16%) and sunflower cake (60.66%). Whereas, safflower seed cake (65.33%), goat manure (67.08%), cotton seed cake (67.66%) and groundnut cake (70.33%) were found less effective.

The average (PESR+PESM) reduction in mortality recorded with all the organic amendments tested were ranged from 15.39 to 64.97% as against 0.00% in untreated control. However, significantly highest reduction in average mortality was recorded with karanj cake (64.97%). This was followed by the organic amendments viz., neem seed cake (43.95%), farm yard manure (37.36%), vermicompost (32.95%), poultry manure (32.24%) and sunflower seed cake (26.87%). Whereas, safflower seed cake (21.40%), goat manure (19.28%), cotton seed cake (18.60%) and groundnut cake (15.39%) were found less effective.

Thus, all the organic amendments applied in sick soil (*R. solanacearum*) were found effective in reducing the pre-emergence seed rot as well as post-emergence seedling mortality in ginger. However, karanj cake was found most effective with highest average reduction in mortality. In the order of merit of effectiveness in reducing mortality, the other organic amendments found effective were neem seed cake, farm yard manure, vermicompost, poultry manure, sunflower seed cake, safflower seed cake, goat manure, cotton seed cake and groundnut cake.

3.2. Effect on growth parameters

Results (Table 2) revealed that all the test amendments

Table 2: Effect of organic amendments application on growth parameters in ginger against *R. solanacearum*

Tr. No.	Germination (%)*	Root length (cm)*	Shoot length (cm)*	Vigour index*
T_1	50.00 (45.00)	4.76	8.83	679.50
T_2	43.33 (41.16)	4.23	6.56	467.53
T_3	60.00 (50.76)	5.26	10.26	931.20
T_4	36.67 (37.26)	4.08	6.13	374.40
T_5	46.67 (43.09)	4.25	8.23	582.44
T_6	33.33 (35.26)	4.60	6.70	376.62
T_7	73.33 (58.90)	6.16	12.56	1372.73
T_8	33.33 (35.26)	3.66	5.13	282.97
T_9	30.00 (33.21)	3.06	6.20	277.80
T_{10}	36.67 (37.26)	3.66	5.96	352.76
T_{11}	20.00 (26.56)	2.36	5.53	157.80
SEm±	2.66	0.25	0.53	-
CD (*p*=0.01)	7.8	0.73	1.55	-

*: Mean of three replications; Figures in parentheses are angular transformed values

improve root length, shoot length and vigour index in ginger. Among the different amendments tested, significantly highest root length (6.16 cm), shoot length (12.56 cm) and vigour index (1372.73) were recorded with Karanj cake. The second best amendment found was neem seed cake (5.26 cm, 10.26 cm and 931.20) respectively. This was followed by the amendments viz., farm yard manure (4.76 cm, 8.83 cm and 679.50), vermicompost (4.25 cm, 8.23 cm and 582.44), poultry manure (4.23 cm, 6.56 cm and 467.53), sunflower seed cake (4.08 cm, 6.13 cm and 374.40), safflower seed cake (3.66 cm, 5.96 cm and 352.76) for root length, shoot length and vigour index respectively. Rest of the amendments except cotton seed cake, goat manure and groundnut cake were found at par to each other and recorded root length 4.60, 3.66, 3.06 cm, shoot length 6.70, 5.13, 6.20 cm and vigour index 376.62, 282.97, 277.80, respectively, as against significantly least root length (2.36 cm), shoot length (5.53 cm) and vigour index (157.80) was found in untreated control.

Results of the present study obtained for the organic amendments viz., karanj cake, neem seed cake, farm yard manure, vermicompost, poultry manure, sunflower seed cake, safflower seed cake, goat manure, cotton seed cake and groundnut cake against *R. solanacearum* are in conformity with those reported earlier by several workers (Lemaga et al., 2001; Schonfeld et al., 2003; Islam and Toyota, 2004; Reddy et al., 2012). Karanj cake found effective in reducing the *Ralstonia* population, maximum plant survival and increase in the yield (Sharma and Kumar, 2000: Sharma and Kumar, 2004). Sharma and Kumar (2009) reported that karanj (*Pongamia*) cake resulted 30.5 and 33.2% reduction in initial *Ralstonia* population at 10 and 20 kg ha^{-1} doses respectively. Disease suppression and survival of the pathogen in the soil differed depending on amendment type and application rate. Higher disease severity was recorded in soil amended with 10% green compost compared to the control treatment. Complete suppression of *R. solanacearum* was observed in pots amended with 5 and 10% farm yard manure, 1% green compost and 10% coco peat (Yadessa et al., 2010).

4. Conclusion

Bacterial wilt is one of the major constraints in the production of ginger, causing heavy quantitative as well as qualitative losses. The studies on evaluation of different organic amendments against bacterial wilt (*R. solanacearum*) disease under pot culture conditions indicated that highest reduction in average mortality was recorded with karanj cake. This was followed by the organic amendments *viz.,* neem seed cake, farm yard manure and vermicompost were found most effective and economical for the management of bacterial wilt of ginger.

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