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LIGNO-PHENOLIC COMPOSTS: POTENTIAL STRATEGY FOR AMARANTH LEAF BLIGHT DISEASE MANAGEMENT

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ABSTRACT
Soil borne pathogens are major factors limiting the productivity of agro-ecosystem and are often difficult to control with conventional strategies. Interest in biological control has increased recently, fuelled by public concerns over the use of chemicals and also by the need to find alternatives to the chemicals used in disease control. We attempt to evaluate the efficacy of ligno-phenolic compost in the management of leaf blight of amaranth caused by *Rhizoctonia solani*. Here we report that the application of ayurvedic compost resulted in low severity of blight of amaranth on split and full basal application. In addition, our study proved that, mixture compost, coir pith and leaf litter composts also significantly reduced leaf blight incidence. Comparing composts, the biometric characters and yield were also higher on application of ayurvedic compost.

KEY WORDS: Leaf blight disease, amaranth, ayurvedic compost, coir ptih compost, mixture compost, leaf litter compost.

INTRODUCTION
Amaranth, the most popular leafy vegetable in Kerala is highly susceptible to leaf blight caused by *R. solani* Kuhn. The disease was first reported from Kerala by Nayar *et al*. (1996). Red varieties of amaranth which are most preferred in the market are more prone to the disease under humid conditions of Kerala. Chemical control measures recommended by Jana *et al*. (1990); KAU (1996) and Gokulapalan *et al*. (1999) have their own limitations in amaranth, being a leafy vegetable. The current awareness of society on pesticide residues in fresh leafy vegetables provides an additional motivation to search for non-chemical means to control pest and diseases. Renewed interest in application of organic matter to soil for the control of soil borne pathogens has been stimulated by public concern about the adverse effects of soil fumigants and fungicides on the environment and the need for healthier agricultural products (Lazarovits, 2001). Various workers have studied the effect of composts and compost products in the management of soil borne plant pathogens. Different mechanisms are hypothesized in the disease suppressiveness by composts and most of them are the results of interactions between the antagonistic microorganisms and the pathogens either by competition, antibiosis or hyperparasitism (Hoitink *et al*., 1993). Certain medicinal plants are reported to have inhibitory effect on phytopathogens due to the presence of alkaloids. Ligno-phenolic agrowastes are rich in alkaloids which are inhibitory to microorganisms. Keeping view of these aspects, we evaluated the efficacy of composted ligno-phenolic agrowaste in the management of leaf blight of amaranth.

MATERIALS & METHODS
Preparation of ligno-phenolic compost
Microbial degraders with ability to degrade cellulose, lignin and tannin isolated on respective selective media were tested on respective and other selective media. The efficient degraders were selected and tested on respective host substrates and other lignin –tannin rich substrates for their degradability under *in vitro* and *in vivo* conditions. Degraders selected were further tested for their compatibility to be included in a consortium. Based on the ability to degrade all the three chemical components, early maturity of composting, type and species of microorganisms and mutual compatibility, microbial degraders were selected for the formulation of microbial consortium. Microbial consortium was evaluated in large scale composting experiments along with cow dung slurry and a combination of both on ligno-phenolic agrowastes *viz.* ayurvedic waste, coir pith, leaf litters of cashew, teak and mango and also on the mixture of these substrates. The ligno-phenolic compost from this experiment was used for the management of leaf blight disease.

Field evaluation of ligno-phenolic compost
A field experiment was laid out to study the efficacy of various ligno-phenolic compost products on the management of leaf blight of amaranth caused by *Rhizoctonia solani*. Composts and cow dung were applied @ 50 t/ha as full basal or in splits. NPK fertilizers and bioagent, *Pseudomonas fluorescens* were also included for comparison. The variety used was Arun, and the experiment was laid out in Randomised Block Design (RBD) with 15 treatments. The treatment detail is as follows:

T1- Ayurvedic compost - full basal
T2- Ayurvedic compost - ½ basal+ ½ top dressing, 30 days after planting (DAP)

T3- Coir pith compost - full basal
T4- Coir pith compost - ½ basal + ½ 30 DAP
T5- Leaf litter compost - full basal
T6- Leaf litter compost - ½ basal + ½ 30 DAP
T7- Mixture compost- full basal
T8- Mixture Compost -½ basal + ½ 30 DAP
T9- Ordinary Compost – full basal
T10- Ordinary compost - ½ basal + ½ 30 DAP
T11- Cow dung @ 50 t/ha - full basal
T12- Cow dung- ½ basal + ½ 30 DAP
T13- Pseudomonas *fluorescens* – 2 per cent – ATP + 30 DAP
T14- NPK fertilizers as per POP @ 50:50:50 kg/ha - ½ basal + ½ 30 DAP
T15- Control (with out treatment)

Preparation of field and transplanting

Experimental field was prepared by ploughing followed by levelling. Shallow trenches were taken with length of 2.5 m and width of 30 cm. Composts/cow dung were applied in the trenches at specified rates and mixed thoroughly. NPK fertilizers were applied as urea, rajphos and muriate of potash @ 109, 250 and 83kg /ha and 2 per cent *P. fluorescens* suspension (20g/l) was applied as soil drenching at the time of planting and 30 days after planting @ 6 l/m^2. Twenty day old seedlings were transplanted in the treated trenches at a spacing of 30 cm between the plants and 30 cm between the rows.

Fifteen plants were randomly selected from each treatment and labelled for taking observations. Observations on plant height, disease severity and yield were recorded.
Disease incidence was observed in all plants at 30 and 60 days after planting (DAP). Per cent disease incidence was calculated using the formula:

$$\text{Per cent disease incidence} = \frac{\text{No.of plants infected}}{\text{Total no.of plants observed}} \times 100$$

Disease severity was recorded from the 15 labelled plants in each treatment Ten leaves were randomly selected from each plant and scoring was done using 0 - 9 scale score chart (Uppala, 2007).

Percent disease severity was calculated using the formula suggested by Wheeler (1969).

$$\text{Per cent disease severity} = \frac{\text{Sum of all numerical ratings}}{\text{Total no.of leaves observed x maximum disease grade}} \times 100$$

Statistical analysis

Analysis of variance was performed on the data collected from the experiment using statistical package, MSTAT (Freed, 1986). Multiple comparisons among the treatments were done using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The experimental results revealed comparatively higher disease incidence in all treatments and the lowest incidence (66.67 and 73.40%) was observed in the treatment (T_8), mixture compost applied in two splits at 30 and 60 DAP (Table 1).

At 30 DAP disease severity was also comparatively higher in all treatments recording 22.29 – 57.26 % against 70.51 per cent in control (Table -1). Minimum severity (22.29 %) was observed in ayurvedic compost applied in splits (T_2) which was on par with coir pith compost applied as full basal -T_3 (22.66 %) and mixture compost applied as splits -T_8 (23.85 %) which showed 68.39, 67.86. and 66.18 per cent reduction over control respectively.
The infection was found to be reduced on new flushes after harvest and significant difference was noticed among the treatments at 60 DAP (Fig. -1).

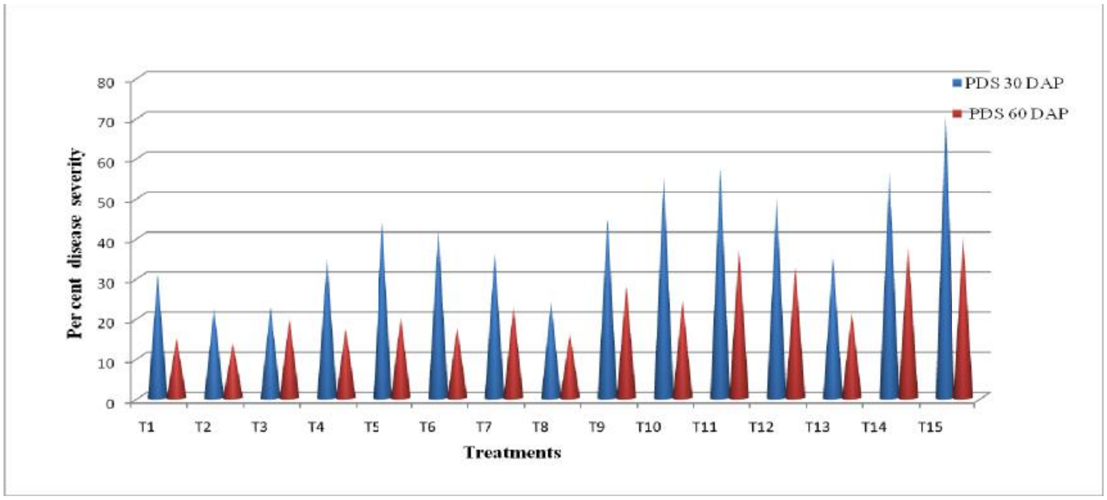

FIGURE 1: Efficacy of various composts on the management of leaf blight of amaranth

TABLE 1. Efficacy of various composts on the management of leaf blight of amaranth

Tr . No.	Treatment details	Per cent disease incidence				Per cent disease severity	
		30 DAP	60 DAP	30 DAP	Per cent reduction over control	60 DAP	Per cent reduction over control
T_1	Ayurvedic compost (Full basal)	100^{a} (10.03)	98.55^{a} (9.95)	30.66^{efg} (5.57)	56.51	14.81^{fg} (3.9)	62.87
T_2	Ayurvedic compost (Two splits)	90.47^{ab} (9.51)	85.92^{a} (9.28)	22.29^{g} (4.74)	68.39	13.61^{g} (3.72)	65.88
T_3	Coir pith compost (Full basal)	91.67^{ab} (9.60)	90.90^{a} (9.52)	22.66^{g} (4.79)	67.86	19.67^{defg} (4.49)	50.69
T_4	Coir pith compost (Two splits)	91.41^{ab} (9.58)	94.44^{a} (9.74)	34.66^{def} (5.89)	50.84	17.29^{defg} (4.22)	56.66
T_5	Leaf litter compost (Full basal)	100^{a} (10.03)	100^{a} (10.03)	43.85^{bcde} (6.66)	37.81	19.99^{defg} (4.51)	49.89
T_6	Leaf litter compost (Two splits)	98.33^{a} (9.94)	98.48^{a} (9.95)	41.85^{bcde} (6.49)	40.65	17.55^{defg} (4.23)	56.00
T_7	Mixture compost (Full basal)	100^{a} (10.03)	96.97^{a} (9.87)	35.88^{cdef} (6.02)	49.11	22.67^{cde} (4.79)	43.17
T_8	Mixture compost (Two splits)	66.67^{c} (8.08)	73.40^{b} (8.55)	23.85^{fg} (4.93)	66.18	15.89^{efg} (4.02)	60.17
T_9	Aerobic compost (Full basal)	76.91^{bc} (8.77)	94.67^{a} (9.75)	44.66^{bcd} (6.72)	36.66	27.99^{bc} (5.34)	29.83
T_{10}	Aerobic compost (Two splits)	100^{a} (10.03)	100^{a} (10.03)	55.21^{ab} (7.39)	21.70	24.32^{cd} (4.97)	39.03
T_{11}	Cow dung @50t/ha (Full basal)	100^{a} (10.03)	100^{a} (10.03)	57.26^{ab} (7.59)	18.79	36.99^{a} (6.12)	7.27
T_{12}	Cow dung @50t/ha(Two splits)	100^{a} (10.03)	100^{a} (10.03)	49.92^{bc} (7.09)	29.20	32.66^{ab} (5.74)	18.12
T_{13}	*Pseudomonas fluorescens* @2.0 %	100^{a} (10.03)	93.34^{a} (9.68)	35.22^{def} (5.97)	50.05	21.22^{cdef} (4.66)	46.80
T_{14}	NPK as per POP	100^{a} (10.03)	100^{a} (10.03)	56.10^{ab} (7.51)	20.44	37.66^{a} (6.17)	5.59
T_{15}	Absolute control	100^{a} (10.03)	100^{a} (10.03)	70.51^{a} (8.42)	-	39.89^{a} (6.36)	-
CD (0.05)		**0.95**	**0.71**	**0.99**	**-**	**0.73**	**-**

*

Mean of three replications DAP- Days after planting Figures in parenthesis are $\sqrt{x + 0.5}$ transformed values
Figures followed by same letter do not differ significantly according to DMRT

TABLE 2. Effect of various composts on plant height and yield of amaranth

Treatments	Treatment details	* Plant height (cm) (30 DAP)	* Yield/5M^2 (kg)
T_1	Ayurvedic compost (Full basal)	32.25^{bc}	2.93^{bcd}
T_2	Ayurvedic compost (Two splits)	38.45^{a}	4.33^{ab}
T_3	Coir pith compost (Full basal)	23.20^{fg}	2.00^{d}
T_4	Coir pith compost (Two splits)	24.5^{efg}	2.83^{cd}
T_5	Leaf litter compost (Full basal)	28.45^{bcde}	2.00^{d}
T_6	Leaf litter compost (Two splits)	30.90^{bcd}	2.50^{bcd}
T_7	Mixture compost (Full basal)	32.90^{b}	2.50^{bcd}
T_8	Mixture compost (Two splits)	28.55^{bcde}	2.67^{bcd}
T_9	Aerobic compost (Full basal)	26.05^{def}	2.63^{bcd}
T_{10}	Aerobic compost (Two splits)	27.15^{cdef}	3.00^{bcd}
T_{11}	Cow dung @50t/ha (Full basal)	39.95^{a}	5.10^{a}
T_{12}	Cow dung @50t/ha (Two splits)	32.20^{bc}	2.66^{bcd}
T_{13}	*Pseudomoans fluorescens* @2.0 %	38.25^{a}	3.90^{ab}
T_{14}	NPK as per POP	29.30^{bcde}	3.33^{abc}
T_{15}	Absolute control	20.05^{g}	2.00^{d}
CD (0.05)		**4.55**	**1.2**

* Mean of three replications

Figures followed by same letter do not differ significantly according to DMRT

The minimum severity (13.61%) was recorded in T_2 which was on par with $T_{1,}$ ayurvedic compost applied as full basal (14.81 %) and $T_{8,}$ mixture compost applied in splits (15.89 %) with 65.88, 62.87 and 60.17% reduction over control respectively. It is also noted that, application of compost products showed less severity as compared to chemical fertilizer and cow dung treated ones and the split application was more effective than full basal application. Many researchers have observed the effect of compost products in the management of *R. solani* (Krause *et al*., 2001; Diab *et al*., 2003 and Scheuerell *et al*., 2005). Sathianarayanan and Khan (2008) observed *in vitro* suppression of *R. solani* with the extracts of composted and vermicomposted coir pith. Similar to this, Sudha and Lakshmanan (2011) also reported suppression of *R. solani* causing rice sheath blight with the application of coir pith composted with fungal degrader, *Lentinus connatus*. The present findings are in confirmation with the results of above researchers.

With regard to plant height and yield (Table 2), T_{11}- cow dung applied as basal, recorded maximum plant height (39.95 cm) and yield (5.10kg/5M^2) which was on par with T_2 - ayurvedic compost applied in splits, recording plant height of 38.45 cm and a yield of 4.33kg/5m^2. In addition, T_{13} - *Pseudomonas fluorescens* (2%) was also equally effective with 38.20 cm, plant height and 3.90 kg/5m^2 yields. Improvement in plant growth by the addition of composts in various crops has been reported by Lazcano *et al*. (2009) and Mrabet *et al*.(2012) and these reports are in agreement with the present results.

CONCLUSION

Composts have been used for centuries to maintain soil fertility and crop health and considerable research have been conducted on the disease suppression by compost products (Hoitink and Fahy, 1986; Schuler *et al*., 1983). Various lignin- tannin rich compost products in the present study were effective in suppressing leaf blight disease of amaranth under field condition. In the present investigation, even though none of the treatments could give complete protection against leaf blight disease, the severity of the disease could be reduced by the application of composts products especially after the first harvest. Among the treatments, ayurvedic compost application was the most effective recording 65.88 - 62.87% reduction over control. In addition mixture, coir pith and leaf litter composts were equally effective in reducing leaf blight infection to 60.17 -50.69%. It is also interesting to note that, the split application was found better than the full basal application with respect to disease severity and yield.

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