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EFFECT OF SOME SHADE TREES AND SOIL AMENDMENTS ON RHIZOME ROT DISEASE OF GINGER

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ABSTRACT

Haque N, Hossain SMM, Hassan SME, Islam ATMS (2015) Effect of some shade trees and soil amendments on rhizome rot disease of ginger. *Int. J. Sustain. Crop Prod.* 10(2), 62-67.

Three experiments were conducted in the research field of Hajee Mohammad Danesh Science and Technology University, farmers' field of Dinajpur and Panchagarh during April 2014 to February 2015 for the management of rhizome rot of ginger. In the first experiment, ginger was grown in the soil amended with cow-dung, compost, mill ash and poultry litter. The compost treatment enhanced plant growth and healthy plants by reducing the disease severity of ginger. Higher yield of ginger was obtained with compost treatment which increased the total rhizome yield of about 1.66% more than the control plot. In the second experiment, ginger was planted in shading condition under neem, mango, litchi and palm tree. Ginger planted under neem tree showed better plant growth, and decreased the incidence and severity of rhizome rot of ginger. Rhizome yield was found higher in all the shading conditions compared to control condition. The highest yield was recorded under neem tree treated plot. In the third experiment, ginger was cultivated under some creepers (bitter gourd, ridge gourd and snake gourd) to observe the shading effect on rhizome rot of ginger. Shade of bitter gourd gave better plant growth and lower disease incidence and severity of rhizome rot of ginger. Consequently, the highest rhizome yield was found under bitter gourd treated plot. It was concluded that rhizome rot of ginger can be minimized by growing in the compost treated plot, under neem tree or bitter gourd creeper.

Key words: *rhizome rot, ginger, soil amendment, shade trees*

INTRODUCTION

Ginger (*Zingiber officinale*) is an herbaceous perennial spice grown as an annual crop. Ginger is an important commercial crop in many tropical and sub-tropical countries including Bangladesh. It has medicinal value, particularly in traditional medicines of India (Lawrence 1984 and Selvan *et al*. 2002). Ginger is cultivated all over the country. It is a regular household item of various dishes in Bangladesh. The production of ginger is 69,508 metric ton from 8,900 hectare of land during 2012-2013 cropping season and average yield is 781 kg/ha (Anon. 2013). The reason of low productivity seems to be continuous use of degenerated seed which is prone to various diseases such as rhizome rot, bacterial wilt, leaf spot, anthracnose, leaf blight, leaf blotch etc. Among them, rhizome rot is the most damaging one (Chattopadhaya 1997). Rhizome rot is a highly destructive disease of ginger causing the loss in some parts of the world to destroy 80 to 90% of the annual crop (Lawrence 1984 and Dake 1995). Rhizome rot is indicated by leaves turning yellow and ultimately wither and die out. The whole shoot is finally affected and the foot of the plant becomes water soaked and soft. The rhizome is discolored and gradually decomposed forming a watery mass enclosed by the tough rind. The roots also rot and the rhizome formation is ceased by *Pythium* sp. (Tripathi 2011). The disease may become epidemic when environmental conditions favor the pathogen. The epidemic factors affecting in favor of disease development are available in the country. But, it is very important to know the factors affecting the disease for evolving the control measures of the disease. It is believed that if ginger is grown under shaded conditions rhizome rot is controlled. But experimental evidence supporting the matter is not available in the country or in abroad. In Bangladesh conditions, very few research work has been done to control this disease. Available literatures indicate that the incidence of rhizome rot in the field can be minimized in different ways. Control measures such as seed treatment, soil treatment, soil amendment, sanitation, drainage, intercropping etc. have some effect in controlling the disease individually (Rahman 2001). But unfortunately such information of control strategies is very much limited in Bangladesh. So, the present research work was taken to find out the effect of soil amendment and shading effect for reducing the severity of rhizome rot of ginger.

MATERIALS AND METHODS

Three experiments were conducted during April 2014 to March 2015 season. The seed rhizomes used for the present study was collected from local market of Dinajpur. Apparently disease free healthy rhizome was selected for the study. Recommended dose of fertilizer and manure suggested by Spices Research Center, BARI, Gazipur were applied in the experimental plot. Cow-dung was applied in the soil at the rate of 10 t/ha during land opening. Urea, TSP and MP at the rate of 150, 350 and 300 kg/ha, respectively was applied. Full dose of TSP and MP were applied during final land preparation. Half of urea was used as top dressing 50 days after sowing of rhizome. Rest half of urea was applied in two installments at 80 days and 110 days after sowing as top dressing.

Experiment 1. Management of rhizome rot of ginger through soil amendment

The experiment was conducted in the farmer's field near HSTU campus, Dinajpur during April 2014 to March 2015. The treatments used in the experiment were T_0 = control, T_1= Soil amendment with mill ash, T_2= Soil amendment with poultry litter, T_3= Soil amendment with compost, T_4= Soil amendment with cow-dung. Cow-dung and poultry litter were incorporated in experimental plot 21 days before sowing at the rate of 2 ton per hectare. Mill ash and compost were incorporated after land preparation in the experimental plot at the rate of 2 ton per hectare. Recommended dose of fertilizer for ginger were applied during land preparation and intercultural operations were done on need basis. After land preparation, pre-sprouted seed (rhizome) was planted on 9th April, 2014 at the rate of 1600 kg/ha. Mulching was done only one time to check weed emergence and conserve moisture during the latter part of the cropping season with rice straw @10 t/ha. The unit plot size was 2.75 × 2.50m, block to block and plot to plot distance was maintained 1.0 and 0.5 m, respectively. Spacing of row to row (within plot) and seed to seed (within row) was 0.70 m and 0.25 m, respectively. The design of experiment was RCBD with three replications. Data were collected four times at an interval of one month starting from the emergence to harvesting of the crop by selecting 10 plants randomly from each plot on the parameters like number of rhizome rot infected plant/plot, percent disease severity of plants using the formula of Johnston (2000). Percent disease severity of rhizome was recorded after harvesting by using 0-9 scale, where 0 = No infection or discoloration on the rhizome, 1 = Rot in 10% area of the rhizome, 3 = Rot in 11-30% area of the rhizome, 5 = Rot in 31-50% area of the rhizome, 7 = Rot in 51-75% area of the rhizome and 9 = Rot in more than 75% area of the rhizome. After harvest of crop, the rhizomes weight were recorded in each plot and it was converted into yield ton per hectare. Collected data were analyzed statistically using the MSTAT-C computer package program. Means were compared by Duncan's Multiple Range Test (DMRT).

Experiment 2. Management of rhizome rot of ginger by shading under tree

The experiment was conducted in the farmers' field of, Mareya village, Boda Upazilla, Panchagarh district. Four field was selected for the experiment where palm tree, mango tree, neem tree and litchi orchard were established by the farmers of Panchagarh district. Ginger was planted under tree as in the treatments T_0 = Control (Ginger planted in open sunny field), T_1 = Shade under palm tree (*Phoenix roebelenii*), T_2 = Shade under mango tree (*Mangifera indica*), T_3 = Shade under neem tree (*Azadirachta indica*), T_4 = Shade under litchi tree (*Litchi chinensis*).

Experiment 3. Management of rhizome rot of ginger by shading under creeper

The experiment was conducted in the research field, Department of Plant Pathology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. Ginger was planted under creeper as in the treatments T_0 = Control, T_1 = Shade under corolla (*Momordica charantia*), T_2 = Shade under jhingha (*Luffa acutangula*), T_3 = Shade under chicingha (*Trichosanthes anguina*). Creeper seed was sown after two month of ginger planted in the field. A top fence (Macha; made of bamboo) was made at 1.5 meter height over the ginger plant to allow the growth of creeper properly and to provide shade on ginger. Necessary cultural operations, fertilization, data collection and analysis of data of experiment 2 and 3 were done as in experiment 1.

RESULTS

Experiment 1. Management of rhizome rot of ginger through soil amendment

Effect of treatment on number of infected plants/plot

The highest (2.33) number of infected plant was recorded in control, poultry litter and cow-dung treated plot at 90 DAS and the lowest (1.00) infected plant was recorded in T_3, where ginger was planted with compost treated plot, which was similar to mill ash treated plot. At 120 DAS, infected plant was recorded the highest (3.00) in T_0, T_2 and T_4 treated plot. The lowest (1.66) number of infected plant was recorded in T_3 treated plot, where compost was used as treatment. At 150 DAS, the maximum (3.66) infected plant was found in T_2 and T_4 which was statistically similar to the T_0 and T_1 and the minimum (2.00) infected plant was recorded in T_3. The data at 180 DAS revealed that the maximum (4.00) infected plants was obtained in T_2 where ginger was planted at poultry litter plot, which was statistically similar to T_0, T_1 and T_4, while the minimum (2.66) infected plant was recorded in T_3 where ginger was planted at compost treated plot (Table 1).

Table 1. Number of infected plants/plot at different dates of sowing as influenced by different soil amendments

Treatments	Number of infected plant/plot			
	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	2.33 a	3.00 a	3.33 a	4.00 a
Mill ash (T_1)	1.66 ab	2.33 ab	3.00 ab	3.33 ab
Poultry litter (T_2)	2.33 a	3.00 a	3.66 a	4.00 a
Compost (T_3)	1.00 b	1.66 b	2.00 b	2.66 b
Cowdung (T_4)	2.33 a	3.00 a	3.66 a	3.66 a
CV %	24.08	23.29	19.76	10.33

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of treatment on disease severity of plant

The highest (17.67%) percentage of disease severity at 90 DAS was found in T_4 which was similar with T_2 (17.33%) and T_0 (15.67%). The lowest (7.33%) percentage of severity was found in T_3 where compost was used as treatment. Considering 120 DAS, the maximum (24.33%) disease severity was found in T_4 treated plot which was similar to T_2 (poultry litter) having 20.67% and T_0 (control) having 20.67%. The lowest (11.33%) severity was recorded in T_3 where compost was used as treatment. At 150 DAS, the maximum (30.67%) severity indices were found in T_4 and the minimum (15.00%) was in T_3. The data at 180 DAS revealed that the maximum (41.00%) severity indices were obtained in T_4 where ginger was planted with cow-dung, while the minimum (17.67%) infected plant was in T_3 where ginger was planted with compost treated plot (Table 2).

Table 2. Severity of rhizome rot at different dates of sowing as influenced by different soil amendments

Treatments	Disease severity of plant (%)			
	90 DAS	**120 DAS**	**150 DAS**	**180 DAS**
Control(T_0)	15.67 ab	20.67 a	26.00 ab	37.00 a
Mill ash (T_1)	9.33 bc	14.00 b	19.33 bc	21.33 b
Poultry litter (T_2)	17.33 a	23.33 a	27.67 a	35.00 a
Compost (T_3)	7.33 c	11.33 b	15.00 c	17.67 b
Cowdung (T_4)	17.67 a	24.33 a	30.67 a	41.00 a
CV %	25.56	18.62	15.15	17.11

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of soil amendments on severity of rhizome rot and yield of ginger

The highest (49.00) disease severity of rhizome was found in T_4, where ginger was planted with cow-dung which was followed by control treatment T_0 (44.33) and T_2 (36.00), where ginger was planted with poultry litter. The lowest (21.33) disease severity of rhizome was recorded in T_3 where ginger was planted with compost followed by T_1 (28.67) where ginger was planted with mill ash. There was variation in yield of ginger was observed among the treatments but the variation was not statistically significant. The yield of ginger ranged from 3.30 to 5.16 t/ha. The highest yield 5.16 ton/ha of rhizome was obtained from T_3, where ginger was planted at compost and the lowest yield 3.30 t/ha of ginger was from T_4, where ginger was planted with cow-dung (Table 3).

Table 3. Effect of different soil amendments on severity of rhizome rot and yield of ginger

Treatments	Disease severity of rhizome (%)	Yield (t/ha)
Control (T_0)	44.33 b	3.50 a
Mill ash (T_1)	28.67 d	4.46 a
Poultry litter (T_2)	36.00 c	3.80 a
Compost (T_3)	21.33 e	5.16 a
Cowdung (T_4)	49.00 a	3.30 a
CV %	6.53	6.15

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Experiment 2. Management of rhizome rot of ginger by shading under tree

Effect of shade trees on number of infected plants/plot

Recorded data indicated that number of infected plants/plot is similar among the treatments at 90 DAS. At 120 DAS, the highest (3.33) infected plant was found in T_1 and T_0 which was followed by T_2 having 3.00 infected plants and the lowest (2.00) was in T_3. At 150 DAS, the maximum (4.33) infected plant was observed in T_1 which was statistically similar to T_0 and T_2 and the minimum (2.33) infected plant was in T_3 that was similar with T_4 having 2.66 infected plant/plot. The data at 180 DAS revealed that the maximum (5.33) infected plants was recorded in T_1, where ginger was planted under palm tree, while the minimum (3.00) infected plants was in T_3 where ginger was planted under neem tree followed by T_4 (3.00) where ginger planted under litchi tree (Table 4).

Table 4. Number of infected plants/plot at different dates of sowing as influenced by different shade trees

Treatments	Number of infected plant/plot			
	90 DAS	**120 DAS**	**150 DAS**	**180 DAS**
Control (T_0)	2.66 ns	3.33 a	3.66 ab	4.33 b
Palm tree (T_1)	3.00	3.33 a	4.33 a	5.33 a
Mango tree (T_2)	2.33	3.00 ab	3.66 ab	4.00 b
Neem tree (T_3)	1.66	2.00 c	2.33 b	3.00 c
Litchi tree (T_4)	1.66	2.33 bc	2.66 b	3.00 c
CV %	31.71	15.97	20.12	8.04

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of shade trees on disease severity

The highest (12.00) percentage of disease severity at 90 DAS was found in T_0 followed by T_1 (10.00) and T_2 (8.33). The lowest (6.33%) percentage of disease severity was found in T_3 which was similar to T_4 having 7.33% disease severity. Considering 120 DAS, the maximum (15.00%) disease severity was found in T_0 treated plot which was similar with T_1 having 14.33% and the minimum(8.66%) disease severity was in T_3 that was statistically similar with T_2 and T_4 having 10.00% and 10.67% disease severity, respectively. At 150 DAS, the maximum (38.33%) severity indices were found in T_0 followed by T_1 (19.33%). On the other hand, the minimum (10.00%) disease indices were recorded in T_3 that was similar with T_2 (12.67%) and T_4 (13.00%). The data at 180 DAS revealed that the maximum (48.33%) severity indices were obtained in T_0 where ginger was planted at control plot, while the minimum (12.00%) severity was in T_3, where ginger was planted under neem tree (Table 5).

Table 5. Percent disease severity of plants at different dates of sowing as influenced by different shade trees

Treatments	% Disease severity of plants			
	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	12.00 a	15.00 a	38.33 a	48.33 a
Palm tree (T_1)	10.00 ab	14.33 a	19.33 b	25.00 b
Mango tree (T_2)	8.33 bc	10.00 b	12.67 c	15.00 c
Neem tree (T_3)	6.66 c	8.66 b	10.00 c	12.00 c
Litchi tree (T_4)	7.33 c	10.67 b	13.00 c	15.00 c
CV %	14.85	13.83	9.56	11.02

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of treatments on disease severity of rhizome and yield of ginger

The highest (49.33%) disease severity of rhizome was found in T_2 where ginger was planted under mango tree which was followed by control treatment T_0 (47.00%). The lowest (19.00%) disease severity of rhizome was recorded in T_3 where ginger was planted under neem tree. The highest 4.43 t/ha yield of rhizome was obtained from T_3, where ginger was planted under neem tree and the lowest 3.51 t/ha yield of ginger was from T_0, where ginger was planted in control plot (Table 6).

Table 6. Effect of different shade trees on disease severity of rhizome and yield of ginger

Treatments	Disease severity of rhizome (%)	Yield (t/ha)
Control (T_0)	47.00 ab	3.51 c
Palm tree (T_1)	42.67 bc	3.73 bc
Mango tree (T_2)	49.33 a	4.00 b
Neem tree (T_3)	19.00 d	4.43 a
Litchi tree (T_4)	40.33 c	4.06 ab
CV %	6.76	5.29

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Experiment 3. Management of rhizome rot of ginger by shading under creeper

Effect of different shade plants (creeping type) on number of infected plants/plot

At 90 DAS, number of infected plants ranged from 2.00 to 4.33, where the highest was found in T_0 and the lowest was in T_1 (corolla) treatment. At 120 DAS, infected plant was recorded the highest (5.66) in T_0 which was followed by T_2 having 4.00 infected plants and the lowest (2.00) was in T_1. At 150 DAS, the maximum (6.66) infected plant was observed in T_0 and the minimum (3.33) infected plant was in T_1. The data at 180 DAS revealed that the maximum (8.00) infected plants was found in T_0 where ginger was planted in control, while the minimum (2.33) infected plants was in T_1 where ginger was planted under corolla (Table 7).

Table 7. Number of infected plants/plot at different dates of sowing as influenced by different shade plants (creeping type)

Treatments	Number of infected plant/plot			
	90 DAS	**120 DAS**	**150 DAS**	**180 DAS**
Control (T_0)	4.33 a	5.66 a	6.66 a	8.00 a
Corolla (T_1)	2.00 c	2.00 c	3.33 c	2.33 c
Ridge gourd (T_2)	3.33 ab	4.00 ab	5.00 b	5.33 b
Snake gourd (T_3)	2.33 bc	2.66 bc	4.00 bc	5.33 b
CV %	19.25	24.61	15.69	11.00

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of different shade plants (creeping type) on percent disease severity of plant

The highest (31.00%) percentage of disease severity at 90 DAS was found in T_0 followed by T_3 (22.33%). The lowest (9.33%) percentage of severity was found in T_1. Considering 120 DAS, the maximum (45.00%) disease severity was found in T_0 plot and the lowest (13.33%) severity was in T_1. At 150 DAS, the maximum (64.33%) severity indices were found in T_0 and the minimum (16.33%) was in T_1. The data at 180 DAS revealed that the maximum (72.33%) severity indices were obtained in T_0, while the minimum (22.33%) infected plant was in T_1 (Table 8).

Table 8. Severity of rhizome rot at different dates of sowing as influenced by shade plants (creeping type)

Treatments	**% Disease severity of plant**			
	90 DAS	**120 DAS**	**150 DAS**	**180 DAS**
Control (T_0)	31.00 a	45.00 a	64.33 a	72.33 a
Corolla (T_1)	9.33 c	13.33 c	16.33 d	22.33 d
Ridge gourd (T_2)	13.33 c	18.33 c	23.33 c	27.67 c
Snake gourd (T_3)	22.33 b	26.67 b	35.00 b	39.67 b
CV %	14.25	13.30	9.72	6.10

Means followed by the same letter(s) within a column do not differ significantly at 5% level

Effect of shade plants (creeping type) on disease severity of rhizome rot and yield of ginger

The highest (58.00%) disease severity of rhizome was found in T_0 where ginger was planted in control plot. The lowest (22.67%) disease severity of rhizome was recorded in T_1 where ginger was planted under corolla plot. The highest 4.90 t/ha yield of rhizome was from T_1, where ginger was planted under corolla and the lowest 3.83 ton/ha yield of ginger was from T_0 (Table 9).

Table 9. Effect of treatments on disease severity of rhizome and yield of ginger at different dates of sowing as influenced by the treatments

Treatments	**Disease severity of rhizome (%)**	**Yield (t/ha)**
Control (T_0)	58.00 a	3.83 b
Bitter gourd (T_1)	22.67 c	4.90 a
Ridge gourd (T_2)	42.00 b	3.90 b
Snake gourd (T_3)	29.67 c	3.90 b
CV %	13.40	8.02

Means followed by the same letter(s) within a column do not differ significantly at 5% level

DISCUSSIONS

Experiment 1. Management of rhizome rot of ginger through soil amendment

Different soil amendments performed moderately against the pathogen, probably by decreasing the pathogen population in soil. The soil amendments used in the experiment were cowdung, mill ash, compost and poultry litter. Of them, compost and mill ash caused better plant growth and minimum disease severity of plants than cow-dung and poultry litter. More or less similar observations have been suggested by Ghorpade and Ajri (1982) and Kausal and Siddique (2003) who worked with a good number of oil cake against wide range of soil borne plant pathogens including *Pythium* spp. They observed that oil cake reduced the incidence of ginger rhizome rot markedly and increased yields. The present study indicates that all of the treatments had some influence on decreased infected tillers and disease severity compared to control. Yield (t/ha) was found maximum in compost and mill ash treated plots which strongly are in agreement with Ghorpade and Ajri (1982), Anon. (2010) and Kausal and Siddique (2003).

Experiment 2. Management of rhizome rot of ginger by shading under tree

The result of the present study reveals that the shading with palm, mango, neem and litchi tree to manage the rhizome rot of ginger have immense impact on the infected plants, disease severity of plants and rhizome and yield of ginger. The highest infected plant was found in T_1, where ginger was planted with palm tree and the lowest was found in T_3, where ginger was planted with neem tree. In such a planting system, ginger plant was grown under different tree plants. So, there is a high competition is occurred among them. This gave early competition for nutrients, light and space, which hampered the early growth of ginger. Though from the findings of Ali *et al*. (2005) it was mentioned that ginger cultivated under gamer and guava gave better plant growth, suppressed disease and increased rhizome yield; however, from the findings of Aclan (1973), it was found that too much light attenuation (75%) reduces yield. Intercropping with okra as alternate row had by reducing the disease severity of ginger and improving the plant growth which was reported by Arjumanara (2013). Among the treatments in the experiment, the T_1 where ginger was planted with palm tree gave the best results by reducing the disease severity. The findings also support the reports of Bhuiyan *et al.* (2012) and Anon. (2009), who reported the better yield of ginger planted with indigenous crops under shade.

Experiment 3. Management of rhizome rot of ginger by shading under creeper

The result of the present experiment showed significant variation among the treatment on plant infection, number of rhizome infection and yield. Considering the yield, all the treatments significantly produced more yield than control. It was found that bitter gourd significantly produced the highest 4.90 t/ha rhizome of ginger.

The findings support the reports of Anon. (2009) and Hossain (2011). They reported the highest seed germination, the lowest disease incidence and more yield were achieved through application of bay leaf, cinnamon, jackfruit garden, under dhaincha and bitter gourd, ridge gourd and snake gourd type of tree and creeper.

CONCLUSION

From this study, it may be concluded that ginger may be cultivated with compost as soil amendment for reducing rhizome rot of ginger. The study also indicated that shading effect of neem tree, litchi tree and bitter gourd creeper could reduce the rhizome rot of ginger and increase the yield.

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