Bangladesh J. Agric. and Environ. 18 (1): 15-20, June 2022

EFFECT OF LEVELS OF *RHIZOCTONIAN SOLANACEARUM* INFECTED SEEDS OF GINGER ON WILT INCIDENCE AND YIELD LOSS

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Abstract

Ginger (*Giniber officinalae* Rosc.) is an important cash crop of Bangladesh. Bacterial wilt caused by *Ralstonia solanacearum* is the most important disease of the spice crop. The present experiment was conducted to assess the effect of different levels of seeds (rhizomes) infection with *R. solanacearum* on wilt incidence, germination and yield loss. The infection levels maintained in the experiment were 0, 5, 10, 20, and 100% and farmer's saved seeds. The experiment was conducted in three consecutive years. The incidence of bacterial wilt, reduction in germination and yield loss of ginger were higher under higher levels of seed infection. Same trends in the results of the experiment were observed during three consecutive years. Average data of three consecutive years showed that wilt incidence was only 8.3% when *R. solanacearum* free seeds were planted and 10.3% at 5% infected seed. Disease incidence was 83.3% in 100% infected seed, 63.0% in farmer's saved seed and 36.7% in 20% seed infection. The average seed germination ranged 67.0-9.01%. The highest germination was found under 100% healthy seed and the lowest in 100% infected seed. The yield of ginger varied 2.6 to 17.7 t/ha. The highest yield was recorded from 100% healthy seed and the lowest from 100% infected seed. The yield decreased with the increase of seed infection level. The highest yield loss (85.02%) was recorded from 100% seed infection followed by farmers saved seed (67.58%) and 20% seed infection (37.2%). The lowest yield loss of 3.5% was recorded from 5% seed infection followed by 10% seed infection showing 18.73%. The findings of the present study are in agreement with the findings of many other researchers.

Key words: Ginger, Seed category, Bacterial wilt, Yield loss.

Introduction

Ginger (*Zingiber officinale* Rosc.) is an important because of its aromatic rhizomes, which are being used as a spice and medicine. Its cultivation is threatened by various diseases, such as rhizome rot, bacterial wilt, leaf spot, anthracnose, leaf blight, leaf blotch, etc. Among the diseases of ginger, bacterial wilt is the most damaging one (Mathew *et al.* 1979, Iyer 1987, Chattopadhya 1989, Akhter *et al.* 2005). Orian (1953) reported bacterial wilt disease for the first time from Mauritius. Ginger is one of the most essential spices in Bangladesh and it is cultivated more or less all over the country. The country produces only 77,000 metric tons of ginger from an area of 9000 hectares as against the requirement of 3,10,000 metric tons per annum (Anon. 2019). Yield of ginger is very low in Bangladesh compared to other ginger growing countries in the world. Every year a good quantity of ginger is imported from abroad. Diseases are considered the major limiting factor for ginger cultivation in Bangladesh caused by *Ralstonia solanacearum, Pythium aphanidermatum*, *Fusarium oxysporum* and *Sclerotium rolfsii.* Among the diseases bacterial wilt (*Ralstonia solanacearum*) is prevalent in most of the ginger growing areas and may

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cause losses to the extent of 50% or more (Joshi and Sharma 1982). The causal organisms perpetuate in infected soil and seeds (rhizomes). Diseased rhizomes are the main factor in the disease dissemination. To reduce disease infection, the best method is to use disease free rhizomes for planting (Anon. 2015). Since the disease is internally seed borne, seed treatments can reduce the infection to a limited extent. Various types of seed treatment have been tried by many workers prior to storage and also prior to planting including chemicals and hot water. Many chemicals have been tried by different workers for seed steeping such as Mercuric chloride 0.1% and Terrazole 0.2% (Iyer *et al.* 1984). Seed steeping in the chemical solution for 30 and 60 minutes were found to be equally effective (Iyer *et al.* 1985, Razu *et al.* 1985). The other important source of infection is the infected soil. In most of the growing areas, 3-5 years crop rotation with non host crops is recommended. Proper drainage of excess water from the fields is also recommended to restrict the disease spread. Early sowing of the crop during May and June has been found to suffer less from bacterial wilt disease (Iyer *et al.* 1984). Application of soil amendments is another method of reducing soil inoculum of the pathogen. Among the various amendments, application of neem cake has been found to reduce the bacterial wilt incidence caused by *Ralstonia solanacearum* (Sadanandan and Iyer 1986). Pordesimo and Raymundo (1963) recommended crop rotation and seed treatment with 0.6% mercurial seed protectants for the control of wilt. Ishii and Aragaki (1963) reported that soil fumigation with Methyl bromide at the rate of 3 lbs/100 sq. ft. checked the disease. Pegg *et al.* (1974) emphasized destruction alternative hosts to check the disease. In 1986, scientists from CPCRI, Calicut reported that incidence of bacterial wilt was delayed by more than a month when seed rhizomes were treated with Streptocycline (200 ppm) or Plantomycin (200 ppm) as compared to untreated or hot water treatment at 45^0C for 30 minutes (Anon. 1986)

Available literatures indicate that the bacterial wilt disease of ginger is difficult to control through chemical and other approaches in the field (Anon. 2015). Therefore, there is an urgent need to address this problem and to select the suitable seed for effective control of the disease. In Bangladesh, bacterial wilt sometimes causes total failure if infection initiates at an early stage of plant growth. The situation drastically aggravates if water logging condition prevails. Use of disease free seed rhizome is recommended in the country to control bacterial wilt and rhizome rot of ginger (Anon. 2015).

The present piece research was conducted to assess the effect of different levels of seeds (rhizome) infection with *R. solanacearum* on wilt incidence, seed germination and yield loss of ginger.

Materials and Methods

The levels of infected seeds (rhizomes) tested in the present experiment were 5, 10, 20, and 100% infection, farmer's practice (Famer's saved seeds) and apparently healthy seeds (0% infection). Each level of infected seeds represented a treatment. The experiment was conducted in three consecutive years, 2016-17, 2017-18 and 2018-19 in the experimental farm of Bangladesh Agricultural Research Institute (BARI), Gazipur-1701, Bangladesh. Recommended doses of manure and fertilizers, cowdung (@ 5 t/ha), N (@ 140 kg/ha), P (@ 54 kg/ha) and K (@ 117 kg/ha) were applied (Anon. 2012). The experiment was laid out following randomized complete block design with three replications. Size of the unit plot was 3.0 m x 2.0 m and hill to hill and plant to plant spacings maintained were 50 cm and 25 cm, respectively. The ginger variety used in the experiment was BARI Ada-1. Rhizomes were planted in well prepared plot on April 15 in three consecutive years. Intercultural operations were done to maintain the normal growth condition of the crop in the field. Data on germination, disease incidence, yield and yield loss were recorded. The recorded data were analyzed statistically using MS Stat SAS analysis of variance and means were compared following Duncan's Multiple Range Test.

Results and Discussion

Effect of different level of seed infection with *Ralstonia solanacearum* on germination of ginger during three consecutive (2016-17, 2017-2018 and 2018-2019) cropping seasons

Bacterial wilt incidence: Bacterial wilt incidence varied from 7.0 to 83.0% in 2016-17, 10.0 to 85.0% in 2017-18 and 8.0 to 82.0% in 2018-19 under different levels of infected seed. The differences in disease incidence among the treatments were significant with two exceptions where at 0 and 5% level of infected seed disease incidence was statistically similar. The highest disease incidence was found at 100% infected seed was planted and the lowest disease incidence (7.0%) was

observed in 100% healthy seed 5, 10 and 20% infected seed. Reduction in disease incidence over 100% infected seed was 91.57, 87.95, 71.08, 56.63 and 21.69% in 2016-17; 88.24, 87.06, 70.59, 58.82 and 24.71% in 2017-18 and 90.24, 87.80, 71.95, 52.44 and 26.83% in 2018-19 under 0, 5, 10, and 20% infected and Farmer's saved seeds, respectively (Table 1).

Germination of seeds: Among different levels of seed infection with *R. solanacearum* and farmer's saved seeds, germination ranged 68-91, 67.0-90.0, and 66.0-92.0% and the reduction in germination was 6.59-25.27, 4.44-25.56 and 5.43-28.26% over control (0% infection) during 2017-2018, 2018-2019 and 2016-2017, respectively. The highest germination was recorded from healthy seed (0% infection) followed by 5, 10 and 20% infected seeds. The lowest germination was found in 100% infected seed followed by farmer's saved seed and 20% infected seed every year (Table 2).

Yield of ginger: Yield of ginger under different levels of *R. solanacearum* infected seed ranged 3.0-17.7, 2.8-17.3 and 2.0-18.0 t/ha during 2016-17, 2017-18 and 2018-19, respectively. Every year, the highest yield was recorded when apparently healthy seeds (0% infection) were planted, which was statistically similar to yield obtained with 5% infected seeds. The lowest yield was recorded when 100% infected were used (Table 2).

The findings of the experiment reveal that wilt incidence decrease with the increase of level of *R. solanacearum* free seed. On the contrary, germination and yield of ginger decrease with the increase of level of *R. solanacearum* infected seed.

Table 1. Effect of different levels of seed infection on incidence of bacterial wilt (*Ralstonia solanacearum*) of ginger in 2016-17, 2017-18 and 2018-19.

Level of Infected seeds (%) (Treatments)	Wilt incidence (%)			% Reduction in disease incidence over control (0% infected seeds)		
	2016-2017	2017-2018	2018-2019	2016-2017	2017-2018	2018-2019
0 % infection (Control)	7.0f	10.0e	8.0e	91.57	88.24	90.24
5% infected	10.0e	11.0e	10.0e	87.95	87.06	87.80
10% infected	24.0d	25.0d	23.0d	71.08	70.59	71.95
20% infected	36.0c	35.0c	39.0c	56.63	58.82	52.44
Farmer's practice	65.0b	64.0b	60.0b	21.69	24.71	26.83
100% infected	83.0a	85.0a	82.0a	-	-	-
CV (%)	7.4	9.1	10.4	-	-	-

Means within the same column with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Table 2. Effect of different levels of seed infection with (*Ralstonia solanacearum*) on germination of ginger in 2016-17, 2017-18 and 2018-19.

Level of Infected seeds (%) (Treatments)	Germination (%)			% Reduction in germination over 0% infected seed		
	2016-2017	2017-2018	2018-2019	2016-2017	2017-2018	2018-2019
0% infection (Control)	91.0	90.0	92.0	-	-	-
5% infected	85.0	86.0	87.0	6.59	4.44	5.43
10% infected	82.0	83.0	82.0	9.89	7.78	10.87
20% infected	79.0	78.0	79.0	13.19	13.33	14.13
100% infected	68.0	67.0	66.0	23.08	21.11	23.91
Farmer's practice	70.0	71.0	70.0	25.27	25.56	28.26
CV (%)	-	-	-	7.4	9.1	10.4

Means within the same column with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Table 3. Effect of different levels of seed infection with *Ralstonia solanacearum* on yield of ginger in three consecutive years (2016-17, 2017-18 and 2018-19).

Level of Infected seeds (%) (Treatments)	Yield (t/ha)			Yield loss over Control %		
	2016-2017	2017-2018	2018-2019	2016-2017	2017-2018	2018-2019
Healthy seed (0% infection)	17.7a	17.3a	18.0a	-	-	-
5% infected	17.1a	17.2a	16.9a	3.4	01.0	6.0
10% infected	14.3b	14.5b	14.2b	19.2	16.0	21.0
20% infected	11.2c	11.4c	10.7c	36.7	34.0	41.0
100% infected	3.0e	2.8e	2.0e	83.1	84.0	88.0
Farmer's practice	5.0d	5.2d	7.0d	71.8	70.0	61.0
CV%	6.3	6.9	8.2	-	-	-

Means within the same column with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Average disease incidence, germination and yield of three consecutive years

The increasing or decreasing trends in averages disease incidence, germination and yield were similar as found in data of 2016-17, 2017-18 and 2018-2019 (Table 4).

Wilt incidence: The lowest wilt incidence of 8.3% was recorded when *R. solanacearum* free seeds were planted, which was statistically similar to disease incidence (10.3%) at 5% infected seed. The highest disease incidence of 83.3% was found under 100% seed infection followed by farmer's saved seed (63.0%), 20% infection (36.7%) and 10% seed infection (24.0%). Disease incidence under those four treatments varied significantly. The maximum average reduction in wilt incidence (90.0%) was found under 0% seed infection followed by 5% seed infection (87.6%) and 10% seed infection (71.2%). The lowest disease reduction of disease incidence (24.5%) was recorded from farmer's saved seed and 20% seed infection (56.0) (Table 4).

Germination: The average seed germination ranged 67.0-9.01%. The highest germination was found under healthy seed (0% infection) followed by 5% seed infection (86.0%) and 10 % seed infection (82.3%). The lowest germination of 67% was found in the treatment

with 100% infected seed followed by farmer's saved seed (70.33%) (Table 4).

The yield of ginger ranged 2.6 to 17.7 t/ha. The highest yield was recorded from 100% healthy seed and the lowest from 100% seed infection. The yield decreased with the increase of seed infection level. The highest yield loss 85.02% was recorded in 100% seed infection followed by farmers saved seed (67.58%) and 20% seed infection (37.2%). The lowest yield loss of 3.5% was recorded from 5% seed infection followed by 10% seed infection showing 18.73% (Table 4).

Table 4. Effect of different levels of seed infection with *Ralstonia solanacearum* on average bacterial wilt incidence, germination and yield of ginger.

Level of Infected seeds (%) (Treatments)	Wilt incidence (%)	Reduction in disease incidence over 100% infected seed	Germination (%)	Yield (t/ha)	% Yield Reduction over 100% healthy seed
Healthy seed (0% infection)	8.3e	90.0	91.0	17.7a	-
5% infection	10.3e	87.6	86.0	17.1a	3.5
10% infection	24.0d	71.2	82.3	14.3b	18.7
20% infection	36.7c	56.0	78.7	11.1c	37.2
Farmer's practice	63.0b	24.5	70.3	5.7d	67.6
100% infection	83.3a	-	67.0	2.6e	85.0

Figures in row and column averages of three consecutive years (2016-17, 2017-18 and 2018-19).
Means within the same column with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Findings of the present investigation reveal that incidence of bacterial wilt, reduction in germination and yield loss of ginger are dependent on level of seed infection with *R. solanacearum*. Higher the seed infection incurred more disease incidence, reduction in germination and yield loss. Similar findings are ported by many other investigators (Anon. 2018, 2019, 2020). In Bangladesh Agricultural Research Institute, effect of five different levels of infected seeds on wilt incidence, germination and yield of ginger were investigated and found that 5% infected seed showed the lowest disease incidence, and the highest germination percentage and yield followed by 10% and 20% seed infection. The yield was decreased with the increase of percent seed infection (Anon. 2018). In another investigation, it was reported that use of 100% healthy seed gave the highest germination and yield with lowest disease incidence. The highest disease incidence with lowest germination and yield were observed in 100% seed infection. The yield was decreased with the increase of percent seed infection (Anon. 2019, 2020). The findings of the present study agree with findings of other researchers.

Conclusion

The wilt incidence, reduction in germination and yield loss increase with the increase of level of seed infection with *R. solanacearum*. Physical sorting of healthy seed manually may reduce bacterial wilt incidence and prevent yield loss of ginger due to bacterial wilt.

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