Original Research Article

Control of Rhizome Rot Disease of Ginger through Application of Fungicides

ABSTRACT

Aims: To determine the effect of seed treatment and foliar spray of fungicide on rhizome rot of ginger.
Study Design: The study was laid out in a randomized complete block design with three replications.
Place and Duration of Study: The experiment was conducted at the plant pathology Field Laboratory
Of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during 2016-2017.
Methodology : Fungicide namely Contuf 5 EC @ 1ml/L water, Bavistin DF @ 1 g/L water, Companion @ 2 g/L water, Fiasta Z-78 @ 2 g/L water, Matco 72 WP @ 2 g/L water, Blitox 50 WP @ 2 g/L water, Cabriotop @ 3 g/L water were applied as seed treatment and foliar spray with one control plot (without fungicide). The total number of unit plots was 24 and the size of unit plot was 15 m × 7 m.
Results: Fungicide Cabriotop was found as the most effective in increasing plant growth and by reducing disease severity of rhizome rot of ginger. Among the treatments, capriotop exhibited least

Keywords: Ginger, rhizome rot, fungicides, disease severity

1. INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) under the family zingiberaceae is one of the most important spices crops in world as well as in Bangladesh. It is an herbaceous tropical and sub-tropical perennial plant and seems to be originated in South-East Asia, probably in India [1,2]. Ginger is an important commercial crop in tropical and sub-tropical countries. It has medicinal value, particularly in traditional medicines of India [3]. Fresh ginger, ginger powder from dry ginger and oil are all used for this purpose. Fresh ginger is unique for its flowery flavor and spicy taste. It is also used in jams and marmalades. The syrup in which ginger is preserved is valued for pickle and sauce making. It is also used in the production of ginger bread [4]. In addition, ginger is used popularly as chewing purpose [5]. Ginger is cultivated in several parts of the world, and the most important countries viz. India, China, Nigeria, Sierra Leone, Indonesia, Bangladesh, Australia, Fiji, Jamaica and Nepal. Among them, India and China are the dominant suppliers to the world market [6]. In Bangladesh, the yield of ginger is not enough to fulfill the national demand of the country. Thus, the vast amount of ginger has to be imported from abroad to fulfill the national demand. Disease is a major constraint for the production of healthy rhizome, cause even total failure of crop [7]. Ginger is affected by various diseases, such as, rhizome rot, bacterial wilt, soft rot, leaf blight etc. Among all of these, rhizome rot is the most damaging one [8]. Rhizome rot or soft rot is a highly destructive disease in ginger; in some areas of the world. Soft rot is known to destroy 80 to 90% yield of the annual crop [9]. In Bangladesh, rhizome rot caused by *Pythium* spp. which can thrive in soil for long time results in loss of total production if infection initiate at early stage of plant growth. Yield of ginger is drastically aggravates during the water logging condition of the soil. The infected rhizomes become rotten and the crop is completely destroyed [10]. The disease is important because it causes economic losses to growers resulting in decreased prices of products to the consumers. It is very important to know the factors affecting the disease severity and control measures of rhizome rot. Control measures such as seed treatment, soil treatment, soil amendment, sanitation, drainage, intercropping etc. have some effect in controlling the disease individually [11]. Rhizome rot of ginger can be controlled by the application of fungicides viz. Contuf 5 EC, Bavistin DF, Companion, Fiasta Z-78, Matco 72 WP, Blitox 50 WP, Cabriotop etc. Many researchers worked on the chemical control of the disease and they found very promising result [12,13]. Systemic and contact fungicides like Bavistin 50WP, Ridomil Gold MZ-72, Captan, Dithane M-45, Copper Oxychloride and Bordeaux mixture etc. were reported effective against the disease [6]. Therefore, the present study was undertaken to find out the most effective fungicide available in Bangladesh in controlling rhizome rot disease of ginger.

2. MATERIALS AND METHODS

2.1 Experimental site: The experiment was conducted at the Plant Pathology Research Field of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

2.2 Duration of the Experiment: The experiment was conducted during April, 2016 to January, 2017.

2.3 Soil type: Soil of the experimental plot was sandy loam with good drainage capacity. The experimental plot was medium high land with the p^H range from 5.5 to 6.0.

2.4 Variety and preparation of propagating unit: Local variety rhizomes of diseased free having 1-2 buds whose average weight 55-60 g. were selected. The collected rhizomes were preserved under soil about one month for pre-sprouting of seed.

2.5 Preparation of the main field: The selected land was harrowed, ploughed and cross-ploughed several times followed by laddering to get a fine tilth. Weeds, stubbles and rubbishes were removed, proper drainage channel were made around the experimental plots and finally obtained a desirable tilth of soil for planting of ginger rhizomes.

2.6 Application of manure and fertilizers: Well decomposed cow-dung @ 7 t/ha was applied during land opening. TSP@ 4 t/ha and MOP @ 3 t/ha, Gypsum @ 2 t/ha were applied at the time of final land preparation. The entire amount of TSP, MOP and Gypsum were applied during the final land preparation of land. Urea was applied after first weeding @2 t/ha.

2.7 Design of the experiment: Single factor RCBD (Randomized Complete Block Design)

2.8 Layout of the experiment: The experiment was conducted with 3 replication having 8 treatments.

2.9 Treatment of the experiment: The treatments were as follows:

T_0 = Untreated (Control),
T_1 = Treatment of ginger with Contaf 5 EC@1 ml /L,
T_2 = Treatment of ginger with Bavistin DF@1 g /L,
T_3 = Treatment of ginger with Companion@2 g /L,
T_4 = Treatment of ginger with Fiasta Z-78@2 g /L,
T_5 = Treatment of ginger with Matco 72 WP@2 g /L,
T_6 = Treatment of ginger with Blitox 50 WP@2 g /L,
T_7 = Treatment of ginger with Cabriotop@3 g /L.

2.10 Time of planting of rhizome: Pre-sprouted rhizome was planted on 2^{nd} week of April, 2016. Seed of ginger was sown at the rate of 1.6 t/ha.

2.11 Sowing of rhizome: Pieces of seed rhizome were sown at the rate of 65g (1 rhizome) per hole. The seeds (rhizome) were placed individually in the furrows and furrow was covered with soil. The plots were earthen up 20 cm high from the level of drain. Finally, the plot was covered with straw of dry rice.

2.12 Data collecting parameters: Data were collected on no. of tillers per plant, plant height (cm), no. of leaves per plant, healthy plant per plot, infected plant per plot and disease severity of plant (%) before harvesting. Data were recorded on 60, 90, 120, 150 and 180 days after sowing (DAS). Disease severity of plant (%) was calculated by using the formula:

$$\text{Disease severity of plants} = \frac{\text{Surface area of plants infected by disease}}{\text{Total surface area of plants}} \times 100$$

Healthy rhizome, diseased rhizome, wt. of healthy rhizome, wt. of diseased rhizome, percent disease severity and yield (t/ha) per plot were recorded at the time of harvest.

2.13 Harvesting: Date of harvesting of ginger was 15th January, 2017. Rhizomes from each plot were harvested separately. The weight of rhizomes was recorded in each plot in kg and it was converted into hectare.

2.14 Data analysis: Collected data were analyzed statistically ~~by~~ using the MSTAT-C computer package program [12].

3. RESULTS

3.1 Effect of fungicides on tiller number per plant

Tiller number per plant of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are presented in Table 1. When tiller number per plant of ginger was recorded at 60 DAS, the highest (5.297) tiller number per plant was found in T_7, where ginger was planted ~~with~~ Cabriotop treated plot which was statistically similar with T_2, T_6, ~~and~~ the lowest (3.607) in T_0, where ginger was planted ~~with~~ control plot. The highest (10.28) tiller number per plant was found in T_7, ~~at 90 DAS,~~ where ginger was planted ~~with~~ Cabriotop treated plot which was statistically similar with T_2, T_4, T_5 and T_6 and the lowest (6.140) tiller number per plant was found in T_0, where ginger was planted with control plot. Tiller number per plant ~~was recorded~~ maximum (18.32) in T_7 ~~at 120 DAS~~, where ginger was planted with Cabriotop treated plot which was statistically similar with T_1, T_2, T_3, T_4, T_5 and T_6 and the minimum 13.85) tiller number per plant was observed in T_0 ~~where ginger was planted with control plot~~. At 150 DAS, tiller number per plant ranged from 17.10 to 20.34 where the highest (20.34) was found in T_5, which was statistically similar with T_1, T_2, T_3, T_4, T_6 & T_7 and the lowest (17.10) in ~~T_0, where ginger was planted with control plot~~. Tiller number per plant at 180 DAS, was ~~recorded the~~ highest (20.91) in T_7, where ginger was planted with Cabriotop treated plot which was statistically similar with T_1, T_2, T_3, T_4, T_5 and T_6 and the lowest (17.55) tiller number per plant was found in T_0, where ginger was planted with control plot.

Table 1. Effect of fungicides on tiller number per plant at different dates of observation

Treatments	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	3.61 c	6.14 d	13.85 b	17.10 b	17.55 b
Contaf 5 EC (T_1)	3.80 bc	7.80 c	16.76 a	18.69 ab	19.25 ab
Bavistin DF (T_2)	5.19 a	9.55 ab	17.88 a	20.20 a	20.54 ab
Companion (T_3)	4.25 bc	8.72 bc	17.46 a	19.61 ab	20.03 ab
Fiasta Z-78 (T_4)	4.42 b	10.1 a	16.68 a	19.46 ab	20.04 ab
Matco 72 WP (T_5)	4.29 bc	9.66 ab	17.22 a	20.34 a	20.86 a
Blitox 50 WP (T_6)	5.25 a	9.40 ab	17.20 a	18.08 ab	18.71 ab
Cabriotop (T_7)	5.30 a	10.29 a	18.32 a	20.24 a	20.91 a
LSD	0.71	1.25	1.86	2.58	2.86
CV %	8.99	8.01	6.30	7.68	8.28

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

3.2 Effect of fungicides on plant height (cm)

Plant height (cm) of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are shown in Table 2. Plant height was recorded the maximum (61.77 cm) in T_6 at 60 DAS, where ginger was planted with Blitox 50 WP treated plot which was statistically similar with T_1, T_4, T_5 and T_7 and the minimum (56.44) plant height was observed in T_0, where ginger was planted with control plot. Plant height at 90 DAS, was recorded the maximum (71.63) in T_7, where ginger was planted with Cabriotop treated plot which was statistically similar with T_1 and T_4. The minimum (66.15 cm) plant height was found in T_3, where ginger was planted with Companion treated plot which was also statistically similar with T_0, T_2, T_5, and T_6. At 120 DAS, the maximum (81.05cm) plant height was found in T_7, where ginger was planted with Cabriotop treated plot which was statistically similar with T_1, T_2, T_3, T_4, T_5 and T_6 and the minimum (76.33cm) plant height in T_0, where ginger was planted with control plot. At 150 DAS, plant height was varied from 85.92 cm to 82.82 cm but the variation was not significant. The maximum plant height was recorded in Cabriotop treated plot and the minimum was in control plot. At 180 DAS, plant height ranged from 60.75 cm to 83.25 cm, where the maximum (83.25 cm) plant height was found in T_7, where ginger was planted with Cabriotop treated plot and the minimum (60.75) was in T_0, where ginger was planted with control treated plot.

Table 2. Effect of fungicides on plant height (cm) at different dates of observation

Treatments	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	56.44 c	68.37 b	76.33 b	85.92 a	60.75 a
Contaf 5 EC (T_1)	60.22 abc	69.84 ab	77.82 ab	81.07 a	79.86 a
Bavistin DF (T_2)	59.56 abc	68.57 b	78.93 ab	81.66 a	82.19 a
Companion (T_3)	56.78 bc	66.15 c	77.56 ab	79.45 a	80.18 a
Fiasta Z-78 (T_4)	58.57 abc	69.95 ab	79.43 ab	82.27 a	82.69 a
Matco 72 WP (T_5)	59.57 abc	68.62 b	77.89 ab	80.12 a	80.55 a
Blitox 50 WP (T_6)	61.77 a	68.85 b	78.96 ab	81.32 a	81.81 a
Cabriotop (T_7)	61.43 ab	71.63 a	81.05 a	82.82 a	83.25 a
LSD	4.31	2.04	3.16	7.42	22.22
CV %	4.15	1.69	2.30	5.18	16.08

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

3.3 Effect of fungicides on leaves/plant

Number of leaves/plant of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are shown in Table 3. When number of leaves/plant of ginger was recorded at 60 DAS, the highest (16.55) leaves/plant was found in T_1, where ginger was planted with Contuf 5 EC treated plot which was statistically similar with T_2, T_3, T_4, T_6 and T_7. The lowest (14.43) number of leaves/plant was recorded in T_0, where ginger was planted with control plot. Leaves/plant was recorded maximum (18.04) in T_7 at 90 DAS, where ginger was planted with Cabriotop treated plot which was statistically similar with other treatments except T_0. The minimum (16.10) number of leaves/plant was observed in T_0, where ginger was planted with control plot. Number of leaves/plant at 120 DAS, was varied from 26.64 to 27.52 where maximum (27.52) was recorded in T_1 and the minimum (26.64) was found in T_6 (Blitox 50 WP) but the variation was not statistically similar. The highest (30.68) leaves/plant were found in T_1 at 150 DAS, where ginger was planted with Contuf 5 EC treated plot which was statistically similar with T_2, T_3, T_5 and T_7. On the other hand, the lowest (28.28) leaves/plant were found in T_0, where ginger was planted with control plot that was similar to T_6 (28.41). At 180 DAS, the highest (31.38) leaves/plant plant was recorded in T_7, where ginger was planted with Cabriotop treated plot which was statistically similar with all other treatments except T_0. The lowest (26.31) leaves/plant were recorded in T_0, where ginger was planted with control plot.

Table 3. Effect of fungicides on leaves/plant at different dates of observation

Treatments	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	14.43 b	16.10 c	26.89 a	28.28 c	26.31 b
Contaf 5 EC (T_1)	16.55 a	17.81 ab	27.52 a	30.68 a	31.38 a
Bavistin DF (T_2)	15.88 ab	17.74 ab	27.12 a	30.16 abc	30.56 a
Companion (T_3)	15.35 ab	16.36 bc	26.85 a	29.47 abc	29.95 ab
Fiasta Z-78 (T_4)	15.79 ab	17.05 abc	26.80 a	28.43 bc	28.80 ab
Matco 72 WP (T_5)	15.93 ab	16.88 abc	27.02 a	30.22 ab	30.79 a
Blitox 50 WP (T_6)	15.55 ab	17.37 abc	26.64 a	28.41 bc	29.10 ab
Cabriotop (T_7)	15.92 ab	18.04 a	27.10 a	30.42 a	30.80 a
LSD	1.56	1.40	1.78	1.72	3.57
CV %	5.71	4.66	3.78	3.33	6.87

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

3.4 Effect of fungicides on healthy plant/plot at different

Healthy plant/plot of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are shown in Table 4. Healthy plant per plot was significantly varied only when data was recorded at 60 DAS but at 90, 120, 150 and 180 DAS healthy plant per plot was not varied significantly. The highest (12.67) number of healthy plant/plot was found in T_7 at 60 DAS, where ginger was planted with Cabriotop treated plot which was statistically similar with T_1, T_2, T_3, T_5 and T_6 and the lowest (10.67) healthy plant/plot was found in T_0, where ginger was planted with control plot. When healthy plant/plot of ginger was recorded at 90 DAS, the highest (11.00) healthy plant/plot was found in T_7, where ginger was planted with Cabriotop treated plot and (9.333) lowest in T_0, where ginger was planted with control plot. At 120 DAS, the (9.33) highest healthy plant/plot was found in T_1, where ginger was planted with Contuf treated plot and the lowest (8.00) in T_0, where ginger was planted with control plot. At 150 DAS, the highest (9.33) healthy plant/plot was found in T_1, where ginger was planted with Contuf treated plot and the lowest (6.33) in T_3 and T_4, where ginger was planted with Companion and Fiasta treated plot, respectively. At 180 DAS, the highest and same number of healthy plant/plot was found in T_1 (6.00), T_5 (6.00) and T_7 (6.00) where ginger was planted with Contuf, Matco and Cabriotop treated plot, respectively. The lowest (5.00) number of healthy plant per plot was recorded in T_1, where ginger was planted with control plot.

Table 4. Effect of fungicides on healthy plant/plot at different dates of observation

Treatments	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Control (T_0)	10.67 c	9.33 a	8.00 a	6.67 a	5.00 a
Contaf 5 EC (T_1)	12.33 ab	10.33 a	9.33 a	8.33 a	6.00 a
Bavistin DF (T_2)	12.33 ab	10.33 a	9.00 a	6.66 a	5.00 a
Companion (T_3)	12.00 ab	10.00 a	8.33 a	6.33 a	5.33 a
Fiasta Z-78 (T_4)	11.33 bc	9.33 a	7.66 a	6.33 a	5.33 a
Matco 72 WP (T_5)	12.33 ab	10.33 a	8.66 a	7.33 a	6.00 a
Blitox WP 50 (T_6)	11.67 abc	10.00 a	9.00 a	7.00 a	5.33 a
Cabriotop (T_7)	12.67 a	11.00 a	9.00 a	7.66 a	6.00 a
LSD	0.97	1.68	2.33	2.49	2.55
CV %	4.67	9.56	15.47	20.20	26.50

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

3.5 Effect of fungicides on infected plant/plot

Infected plant/plot of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are shown in Table 5. Infected plant/plot varied significantly when data was recorded at 60 DAS, but at the later stage of plant growth infected plant per plot was not varied significantly when data was recorded at 90, 120, 150 and 180 days after sowing. At 60 DAS, infected plant per plot was found the highest (3.33) in control treatment T_0, which was similar with T_4 (2.67) and T_6 (2.33). The lowest (1.33) number of infected plant per plot was recorded in T_7, where ginger was planted with Cabriotop treated plot. Infected plant/plot was recorded the maximum (4.67) in T_0 at 90 DAS, where ginger was planted with control and the minimum (3.00) infected plant/plot was observed in T_7, where ginger was planted with Cabriotop treated plot. At 120 DAS, infected plant/plot ranged from 4.67 to 6.33, where the highest (6.33) was found in T_4, where ginger was planted with Fiasta Z-78 treated plot and the lowest (4.67) infected plant/plot in T_1, where ginger was planted with Contuf 5 EC treated plot. The highest (7.67) infected plant/plot was found in T_4 at 150 DAS, where ginger was planted with Fiasta Z-78 treated plot and the lowest (5.67) infected plant/plot infected plant/plot was found in T_1, where ginger was planted with Contuf 5 EC treated plot. When data was recorded at 180 DAS, the highest (9.00) infected plant/plot was found in T_0, where ginger was planted with control plot and the lowest (8.00) infected plant/plot in T_1, where ginger was planted with Contuf 5 EC treated plot.

Table 5. Effect of fungicides on infected plant/plot at different dates of observation

Treatments	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Control(T_0)	3.33 a	4.67 a	6.00 a	7.33 a	9.00 a
Contaf 5 EC(T_1)	1.67 bc	3.67 a	4.67 a	5.67 a	8.00 a
Bavistin DF(T_2)	1.67 bc	3.67 a	5.00 a	7.33 a	9.00 a
Companion(T_3)	2.00 bc	4.00 a	5.67 a	7.67 a	8.67 a
Fiasta Z-78(T_4)	2.67 ab	4.67 a	6.33 a	7.67 a	8.67 a

Matco 72 WP(T_5)	1.67 bc	3.67 a	5.33 a	6.67 a	8.00 a
Blitox 50 WP(T_6)	2.33 abc	4.00 a	5.00 a	7.00 a	8.67 a
Cabriotop (T_7)	1.33 c	3.00 a	5.00 a	6.33 a	8.00 a
LSD	0.97	1.69	2.33	2.49	2.55
CV %	26.70	24.60	24.82	20.44	17.15

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

3.6 Effect of fungicides on disease severity of plant

Percent disease severity of ginger was recorded at 60, 90, 120,150 and 180 DAS and the results are shown in Figure 1. Disease severity varied significantly when data was recorded at 60 DAS, but at the later stage of plant growth disease severity was not varied significantly when data was recorded at 90, 120, 150 and 180 days after sowing. At 60 DAS, the highest disease severity was found in control treatment (T_0), which was similar with T_5 and T_6. The lowest amount of disease severity was recorded in T_7 where ginger was planted with Cabriotop treated plot. Disease severity recorded the maximum in T_0 at 90 DAS, where ginger was planted with control treatment and the minimum disease severity was observed in T_7, where ginger was planted with Cabriotop treated plot. At 120 DAS, the highest disease severity was recorded in T_0 and the lowest in T_1, where ginger was planted with Contuf 5 EC treated plot. The highest disease severity was found in T_0 (control) at 150 DAS, and the lowest was found in T_1, where ginger was planted with Contuf 5 EC treated plot. When data was recorded at 180 DAS, the highest disease severity was found in T_0, where ginger was planted with control plot and the lowest and same was in T_1, T_5 and T_7 treatments.

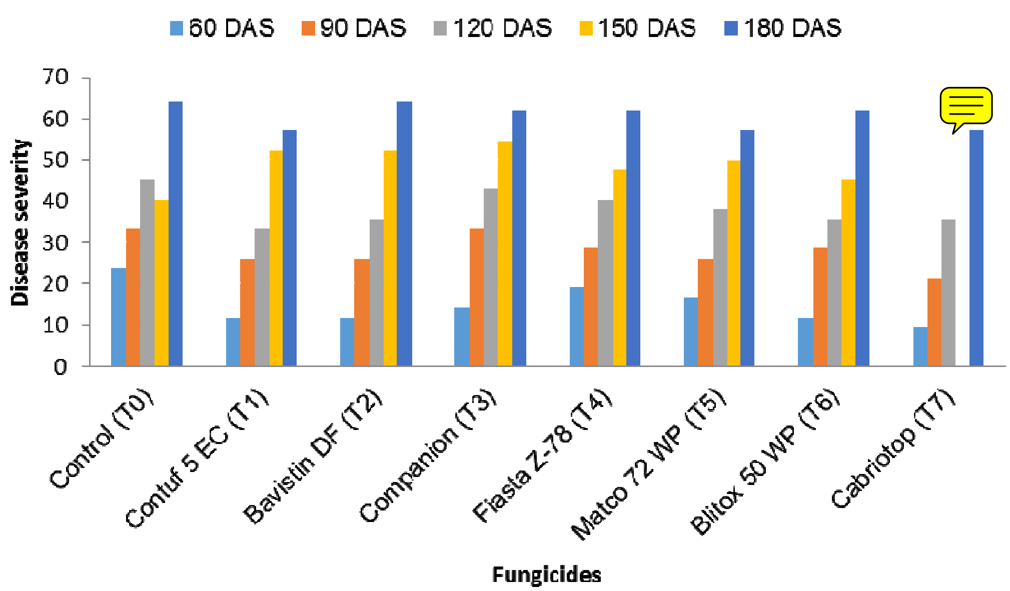

Fig.1. Effect of fungicides on disease severity of plant at different dates of observation

3.7 Effect of fungicide on healthy rhizome, diseased rhizome, percent disease severity and yield (t/ha) of rhizome

Effect of healthy rhizome, disease rhizome and yield (t/ha) of rhizome were recorded after of the harvesting of rhizome and presented in the Table 6. Number and weight of healthy rhizome was recorded the highest in Cabriotop treated plot followed by Contuf and Bavistin treated plot. On the other hand, the lowest number and weight of healthy rhizome was recorded in the Control treatment. Number and weight of disease rhizome was found maximum in the control treatment and minimum in Cabriotop treatment. Disease severity of rhizome was recorded maximum in control plot and the minimum was in Cabriotop treatment treated plot. Yield of the rhizome recorded the highest in Cabriotop treatment and minimum in Control treatment.

Table 6. Effect of fungicide on healthy rhizome, diseased rhizome, percent disease severity and yield (t/ha) of rhizome.

Treatments	Healthy rhizome		Diseased rhizome		Disease severity of rhizome	Yield (t/ha)
	Number /plot	Weight /plot	Number /plot	Weight /plot		
Control (T_0)	5.00 e	0.15 c	28.33 a	0.73 a	71.03 a	0.33 c
Contaf 5 EC (T_1)	17.67 b	0.84 b	14.67 bc	0.62 ab	59.67 a	1.84 b
Bavistin DF (T_2)	12.33 c	0.36 c	23.67 abc	0.60 ab	65.88 a	0.76 c
Companion (T_3)	10.33 cd	0.27 c	17.67 abc	0.37 bc	63.01 a	0.58 c
Fiasta Z-78 (T_4)	8.33 cde	0.33 c	16.33 abc	0.49 abc	65.25 a	0.70 c
Matco 72 WP (T_5)	7.00 de	0.35 c	15.33 abc	0.51 abc	69.04 a	0.74 c
Blitox 50 WP (T_6)	6.33 de	0.34 c	27.00 ab	0.43 abc	70.32 a	0.72 c
Cabriotop (T_7)	32.67 a	1.92 a	12.33 c	0.28 c	45.08 b	4.13 a
LSD	4.18	0.29	11.95	0.28	11.83	0.63
CV %	19.18	35.16	29.60	31.76	10.61	29.42

Figures in a column having common letter(s) do not differ significantly at 5% level of significance. CV = Coefficient of variation;

4. DISCUSSION

Rhizome rot is ranked one and the most destructive disease of ginger which may results in total loss of affected crop. The effect of fungicides was investigated to minimize the losses caused by the disease. The results of the present study revealed that all the fungicides have good impact on plant growth, rhizome yield with reduced disease incidence and severity. Sasikumar et al. [13] reported that the treatment of seed rhizomes with mancozeb 0.3 percent for 30 minutes before storage and once again before planting reduces the incidence of the disease. In the present study Contaf 5 EC, Bavistin DF, Companion, Fiasta Z-78, Matco 72 WP, Blitox 50 WP and Cabriotop proved their effectiveness to increase the plant growth and suppress the disease of ginger compared to control. The result of the present experiment showed significant variation among the treatments on tiller number per plant and plant height. Significantly higher tiller number per plant and plant height were recorded when seed treatment and foliar spray were applied with fungicide compared to control at 180 DAS. This might have happened due to reduction of primary and secondary inocula of pathogen present in seed and soil. The application of fungicide may also inhibit the growth of fungi. Similar result was reported by Rahman [11] who found that number of tiller per plant was the highest in Ridomil and Secure treated plot and the plant in control plot is shorter than the fungicidal treated plot. Under the present investigation, the fungicide Cabriotop was found as the most effective for yielding maximum number of leaves per plant compared to control treatment. Other fungicide tested also had some influence on number of leaves per plant over control. Maximum number of leaves per plant was the indication of minimum amount of disease. All the fungicide treated plots produced lower percent of infected plants compared to control treated. In addition, higher percent of healthy plants were found in fungicide treated plots compared to the control treated. The present findings are envisaged with the findings of Rahman [11], BARI [14] and BARI [15] all mentioned that Ridomil resulted in the lowest number of dead plants per plot whereas the highest was found in control. Ara [16] reported that the use of Secure and Antracol as seed treatment decreased the number of rhizome rot infected plants. Ramachandran et al. [17] also reported that five systemic fungicides namely Fosetyl aluminium, Metalaxyl, Oxadiaxyl 25 WP, Propamocarb and Ethazole gave the best result in controlling rhizome rot of ginger. Although in this experiment, all the fungicide treated plots showed the better results over control but Cabriotop treated plots resulted as best by reducing disease severity and number of rhizome rot infected plants. The present findings are in line with Hossain et. al. [18] who reported that fungicide Antracol, Folicur and Secure were effective in reducing the incidence and severity of rhizome rot and improved plant growth. Ichitani [19] also reported that rhizome rot incidence was reduced by seed treatment with fungicides namely Echlomezol and Methyl bromide. In case of yield of ginger, all the treatments were recorded with significantly higher yield than control. However, the plots treated with Cabriotop resulted in significantly highest yield of ginger (4.13 t/ha). The result of the present study was also supported by many other scientists who conducted different experiments by using various fungicides. Ghorpade and Ajri [20], Dohroo and Sharma [21], Rathaiah [22] and Jayasekhar et al. [23] also reported the highest seed germination, lowest disease incidence and more yield of ginger trough application of fungicide Ridomil.

5. CONCLUSION

From the present study, it can be concluded that the application of different fungicides have significant importance on plant height, number of tillers, number of leaves, infected plants, disease severity of plants and yield of ginger. But among all the treatments, Capriotop was found as the best with highest yield (4.13 t/ha) of ginger by increasing other yield contributing parameters and reducing disease severity.

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