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AN INTEGRATED APPROACH TO MANAGE THE RHIZOME ROT DISEASE OF GINGER

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Abstract

An experiment was conducted at Gazipur, Bogura and Ramgarh to observe the effect of eight different treatments packages on rhizome rot of ginger. The package comprising of seed treated with Chlorox (10%) + Soil treatment with Stable Bleaching Powder (20 kg/ha) + Soil drenching with Chlorox (10%) and Ridomil (0.2%) alternately for 5 times each gave superior or better results in respect of germination(80-97%), disease reduction(50-62%) and crop yield (24 t/ha) of ginger in all locations. The same package showed disease reduction ranging from 53 to 57.33% at Nilphamari, Rangpur, Bogura, Madhupur and Ramgarh in the validation trials and thereby produced higher yield of ginger 24.8 t/ha at Bogura, 23.6 t/ha at Rangpur, 23.2 t/ha at Nilphamari and 22.6 t/ha at Ramgarh. The same package also gave higher benefit cost ratio (BCR) of 4.85 in case of experiment and 4.58 in case of validation trials. This package was therefore seemed to be cost effective in reducing rhizome rot disease of ginger and accelerate the yield if applied properly.

Keywords: Ginger, Rhizome rot, Integrated management.

Introduction

Ginger (*Zingiber officinale* Rosc.) is important because its aromatic rhizomes are being used as spice and medicine. Major producing countries of ginger in the world are India, Jamaica, Sierra Leone, Nigeria, Southern China, Japan, Taiwan and Australia. Though the crop is affected by many diseases rhizome rot is prevalent in most of the ginger growing areas and may cause losses to the extent of 50% or more (Joshi and Sharma, 1982). The disease was first reported in 1907 by Butler from Bengal and Gujrat and thereafter reported from almost all the ginger growing countries of the world (Chauhan and Patel, 1990; Dohroo *et al.*, 1987; Iyer, 1987).

Ginger is one of the most essential spices in Bangladesh and is cultivated more or less all over the country. Bangladesh 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., 2018). The yield of ginger in Bangladesh is very low

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compared to other ginger growing countries in the world. Every year a good quantity of ginger is imported from abroad in exchange of foreign currency. Dseases are to be considered the major limiting factor for ginger cultivation in Bangladesh caused by *Pythium aphanidermatum*, *Fusarium oxysporum*, *Sclerotium rolfsii* and *Ralstonia solanacearum.*

The causal organisms/agents perpetuate through infected soil and seeds (rhizomes). Diseased rhizomes are considered to be the main factor in the disease dissemination. To reduce disease infection, best method is to use disease free rhizomes for planting (Anon., 2015). Since the disease is internally seed borne also, 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%, Bavistin 0.3%, Dithane M-45 0.3% and Terrazole 0.2% (Iyer *et al.,* 1984). Two varying duration of seed steeping in the chemical solution *viz*., 30 minutes and 60minutes 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, crop rotation of 3-5 years is suggested to be practiced as routine. Proper drainage of excess water in the fields is recommended to reduce the disease spread. Early sowing of the crop during May and June has been found to suffer less from soft rot 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 soft rot incidence (Sadanandan and Iyer, 1986). Biological control of the pathogen by using well established antagonists has been attempted by several workers. Antagonistic activity of *Trichoderma* species in dual cultures against causal fungi of rhizome rot of ginger was demonstrated by Bhardwaj and Gupta (1987). Steeping inoculated rhizome in a spore suspension of *T. viridae* was quite effective against *P. aphanidermatum* and *Fusarium equisetti* on seed ginger. Another method of controlling the disease in the field is through fungicides. Soil and seed treatment with Ridomil 5G and Apron 35 WS gave the best control of the disease in infected plots (Ramchandra *et al.,* 1989). Available literatures indicate that the rhizome rot disease of ginger is difficult to control through single option in the field (Anon., 2015). Therefore, there is an urgent need to address this problem and to develop a combined management options for effective control of the disease. So the present study was undertaken to develop an integrated management package for controlling rhizome rot disease of ginger.

Materials and Methods

a) On-station

The experiments were conducted at Gazipur, Bogura and Ramgarh (Khagrachari) to develop a sustainable management package for controlling the rhizome rot

disease of ginger through an integrated approach during 2015-16 and 2016-17 cropping seasons. Recommended fertilizer doses and proper intercultural operations were applied in all the experiments. Cowdung @ 5 t/ha, N @ 140 kg/ha, P @ 54 kg/ha and K @ 117 kg/ha were applied. The experiments were carried out following Randomized Complete Block Design with three replications. Size of the unit plot was 3.0m x 2.0 m and plant spacing was maintained 50 cm x 25 cm. Variety 'BARI Ada -1' was used in the experiment. There were 8 treatments in the experiment *viz*., T_1= Mustard oil cake (300 kg/ha), T_2= Poultry refuge (5t/ha), T_3= Stable Bleaching Powder (SBP) @ 20kg/ha, T_4= Seed treatment with Chlorox (10.0%), T_5= Bavistin (0.2%) seed treatment + 2 times soil drenching with Bavistin (0.2%) , T_6= Ridomil (0.2%) seed treatment + 2 times soil drenching with Ridomil (0.2%), T_7= Seed treatment with Chlorox (10%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox (10.0%) & Ridomil (0.2%) alternately for 5 times each and T_8= Control.

Rhizomes were planted on April 15, 2015. Intercultural operations were done to maintain the normal hygienic condition of the crop in the field. Data were recorded on germination, percent infected plants and yield. The recorded data were analyzed statistically to find out the level of significance and the variance was analyzed following Duncan's New Multiple Range Test (DMRT).

b) Validation Ttrial

Based on the results of trials obtained from first year, a validation trial was conducted in farmer's fields of five different districts with the best treatment package and control treatment during 2016-17 cropping season. The locations of validation trial were Nilphamari, Rangpur, Bogura, Madhupur (Tangail) and Ramgarh (Khagrachari). The trials were replicated thrice. The design of the trials was paired plot. 'BARI Ada-1' was sown at all locations. The two selected treatments of validation trials were: T_1= Seed treatment with Clorox (10%) + Soil treatment with SBP (20 kg/ha) + Soil drenching with Clorox(10.0%) and Ridomil(0.2%) alternately for 5 times and T_2= Control. Data on germination, disease incidence and yield were collected from the validation trials. The data were analyzed statistically and the means were separated by Duncan's New Multiple Range Test (DMRT) for interpretation of the results.

Economics of the Research

Cost Benefit ratio for application of package treatment for management of rhizome rot disease of ginger was done based on the current market price of input, rate of hiring labour and agricultural machineries. Estimation of Benefit Cost Ratio (BCR) was calculated according to Gitting (1982) using the following formula:

Benefit Cost Ratio (BCR) = Gross return (Tk./ha)/Total cost of production (Tk./ha).

Results and Discussion

a) On-station experiment

The germination of rhizome ranged 80.0-97.0% under different treatments at various locations. The highest germination was observed (97.0%) at Bogura in T_4 treatment (Table 1) and the lowest germination 86.0% was found in control treatment (T_7). Similar result was also obtained from Gazipur. However, the germination was lowest at Ramgarh.

Table 1. Effect of treatments on germination, diseases incidence and yield of ginger at different locations during 2015-16

Treatments	Bogura			Gazipur			Ramgarh	
	Germination (%)	Disease incidence (%)	Yield (t/h)	Germination (%)	Disease incidence (%)	Yield (t/h)	Germination (%)	Disease incidence (%)
T_1= Mustard oil cake (300kg/ha)	87.0	50a	8.5f	83.0	45.66b	10.0g	80.0	51.66b
T_2= Poultry refuge (5t/ha)	88.0	48c	11.6e	87.0	44.66b	12.9f	81.0	50.00b
T_3= Stable bleaching powder (20kg/ha)	89.0	11f	12.0e	90.0	9.00de	13.9e	87.0	12.00d
T_4= Seed treatment with Chlorox (10.0%)	97.0	13e	22.8b	97.0	11.00d	22.5b	86.0	14.00d
T_5= Bavistin seed treatment + 2 times soil drenching with Bavistin	88.0	17.66d	12.53d	89.0	15.00c	16.96d	83.0	20.000c
T_6= Ridomil seed treatment + 2 times soil drenching with Ridomil Gold	92.0	8.00g	14.7c	93.0	7.33ef	19.06a	84.0	8.33e
T_7= Seed treatment with Chlorox (10.0%) + Soil treatment with Stable Bleaching Powder (20kg/ha) + Soil drenching with Chlorox & Ridomil Gold alternately for 5 times	96.0	7.00g	24.7a	97.0	6.00f	24.00a	86.0	6.67e
T_8= Control	86.0	55.00a	6.53g	82.0	50.00a	5.93h	80.0	62.00a
LSD value	-	1.991	0.4107	-	2.228	0.4325	-	3.77
CV (%)	-	4.33	1.65	-	5.40	1.52	-	2.215

The disease incidence was significantly reduced in all treatments over control (Table 1). The disease incidence ranged from 50.0-62.0 % in control (T_8) plots whereas the lower incidence ranged from 6-7% was observed in T_7 treatment where seed treatment with Chlorox (10.0) % + Soil treatment with stable bleaching powder, 20kg/ha + Soil drenching with Chlorox and Ridomil alternately for 5 times were applied. The higher yield ranging from 24.0-24.70 t/ha was obtained from T_7 at Gazipur and Bogura followed by 22.80 t/ha and 22.50 t/ha at Bogura and Gazipur in the treatment T_4. The lowest yield 5.93 t/ha was obtained in Gazipur and 6.53 t/ha in Bogura from untreated control (Table 1).

The result of the present study indicated that combined application of seed treatment with Chlorox (10.0%) + Soil treatment with Stable Bleaching Powder (20kg/ha) + Soil drenching with Chlorox and Ridomil alternately for 5 times gave good control of rhizome rot disease as well as increased yield of ginger. Rathaiah (1987) also reported that soft rot of ginger was controlled by using Ridomil in combination of Captofal/Mancozeb as wetting of seed (rhizome) pieces before planting and soil drenching of Ridomil and Captofal significantly increased yield of ginger.

b) Validation trials

The validation trials to control the rhizome rot were conducted at five locations viz. Nilphamari, Rangpur, Bogra, Madhupur and Ramgarh in farmer's field for confirming the treatment-effect obtained as promising in the first year results with some modifications. The package treatment (T_1= Seed treatment with Chlorox (10%) + Soil treatment with SBP (20 kg/ha) + Soil drenching with Chlorox(10%) and Ridomil Gold (0.2%) alternately each for 5 times gave better performance both in relation to germination of ginger and reduction of rhizome rot, irrespective of locations. The germination ranged from 82-97% over the locations of Nilphamari, Rangpur, Bogura, Madhupur and Ramgarh in the package treatment, whereas it was 78-89% in the same locations in the control plot (Table 2).

Table 2. Effect of package treatment on the germination of ginger at 5 locations during 2016-17

Treatment	Germination (%)				
	Nilphamari	Rangpur	Bogura	Madhupur	Ramgarh
T_1= Seed treatment with Chlorox (10.0%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox & Ridomil Gold alternately for 5 times application	96	94	95	97	82
T_2= Untreated control	88	86	85	89	78
Increased germination over control (%)	9.09	9.30	12.0	9.0	5.12

Similarly, 53-60.33% reduction of disease incidence was observed in the package treatment compared to control plot at Nilphamari, Rangpur, Bogra, Madhupur and Ramgarh (Table 3). Considering the yield, the highest yield 24.8 t/ha was obtained at Bogura followed by 23.6 t/ha at Rangpur, 23.2 t/ha Nilphamari, 22.6 t/ha at Madhupur and 21.24a t/ha in Ramgarh in the package treatment. The control treatment gave the lowest yield at all locations (Table 4).

Table 3. Effect of package treatment on rhizome rot disease incidence of ginger at various locations during 2016 -17

Treatment	Rhizome rot incidence (%)				
	Nilphamari	Rangpur	Bogura	Madhupur	Ramgarh
T_1= Seed treatment with Chlorox (10.0%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox & Ridomil Gold alternately for 5 times.	6.00 b	6.33 b	8.00 b	7.0 b	8.0 b
T_2= Control	63.33 a	60.00 a	61.00 a	67.33 a	65.00 a
Reduction of rhizome rot (%)	57.33	53.77	53.00	60.33	57.00
CV (%)	2.36	1.23	19.55	3.86	1.94

Table 4. Average yield of ginger from various locations under package treatment during 2016-17

Treatment	Yield (t/ha)				
	Nilphamari	Rangpur	Bogura	Madhupur	Ramgarh
T_1= Seed treatment with Chlorox (10.0%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox & Ridomil Gold alternately for 5 times.	23.20a	23.60a	24.80a	22.60a	21.24a
T_2= Control	6.10b	6.40b	6.60b	5.80b	5.65b
Yield increased over control (%)	73.70	72.88	73.39	74.34	70.49
CV (%)	2.10	2.16	1.35	1.49	1.32

It is clear from the results that 78.0-96.0% germination observed in the validation trials where the rhizome rot disease incidence was comparatively less in treated plot. The present findings is supported by Anon. (2006) who showed that, minimum disease incidence (16.40 %) was recorded by one hour seed treatment with Ridomil MZ (3g/l of water) followed by Indofil M-45 (25.30 %). Integration of different components had a significant influence compared to single component on the incidence of rhizome rot disease and yield of ginger (Anon., 2013, Anon., 2014 and Anon., 2015). In addition Stable Bleaching

Powder (12 kg/ha) mixed in furrows at the time of planting could reduce the bacterial wilt of potato by 80 per cent (Shekhawat *et al*., 1988).

Table 5. Benefit Cost Ratio (BCR) of developed technology for controlling rhizome rot disease of ginger in field experiment.

Treatment	Average yield (t/ha)	Gross return (Tk.)	Total cost (Tk.)	BCR
T_1= Mustard oil cake (300kg/ha)	9.25	1110000	545400	2.03
T_2= Poultry liter (5t/ha)	12.25	1470000	548403	2.68
T_3= SBP (20kg/ha)	12.95	1554000	589275	2.63
T_4= Seed treatment with Chlorox (10.0%)	22.65	2718000	589275	4.61
T_5= Bavistin seed treatment + 2 times soil drenching with Bavistin	14.74	1768800	539403	3.27
T_6= Ridomil seed treatment + 2 times soil drenching with Ridomil Gold	16.88	2025600	597900	3.38
T_7= Seed treatment with Chlorox (10.0%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox & Ridomil alternately for 5 times.	24.35	2922000	602475	4.85
T_8= Control	6.23	747600	505000	1.48

Table 6. Benefit Cost Ratio (BCR) of a package technology for controlling rhizome rot disease of ginger in validation.

Treatment	Average yield (t/ha)	Gross return (Tk.)	Total cost (Tk.)	BCR
T_1= Seed treatment with Chlorox (10.0%) + Soil treatment with SBP (20kg/ha) + Soil drenching with Chlorox and Ridomil Gold alternately for 5 times application	23	27 60000	602475	4.58
T_2= Control	6	720000	505000	1.43

Economic analysis

Benefit Cost Ratio (BCR) of the field experiment as well as validation trial were estimated according to Gitting (1982). It was found that the teatment T_7 i.e. Seed treatment with Chlorox (10%) + Soil treatment with SBP (20 kg/ha) + Soil drenching with Chlorox (10%) and Ridomil Gold (0.2%) alternately for 5 times yielded the highest return showing benefit cost ratio (BCR) 4.85 followed by treatment T_4= Seed treatment with Chlorox (10.0%) with BCR 4.61. Benefit cost ratio were 3.38 and 3.27, respectively for the other promising treatment T_6=

Ridomil seed treatment + 2 times soil drenching with Ridomil Gold and T_5= Bavistin seed treatment + 2 times soil drenching with Bavistin in compared to control (Table 5). In validation trial the benefit cost ratio was more than four times (4.58) higher than control treatment (T_2).

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