Control of Red Rot (*Colletotrichum falcatum*) by Heat Therapy and Its Effect on Germination and Yield

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ABSTRACT

Red rot *(Colletotrichum falcatum)* infected setts collected from the artificially inoculated canes of the susceptible variety Isd 5/55 after one month of inoculation were treated with moist hot air at 54°C for 2, 3 and 4 hours at above 95% relative humidity in moist hot air treatment (MHAT) plant and at 50°C for 3 hours in hot water treatment (HWT) plant. Moist hot air treatment for 3 and 4 hours controlled the red rot pathogen from tissue samples by 100%, while 98.5% control was achieved by MHAT at 54°C for 2 hours and 97.0% by HWT at 50°C for 3 hours. However, the efficacy of treatment varied with the duration and treatment methods. MHAT at 54°C for 2 and 3 hours increased germination significantly compared to 4 hours and HWT at 50°C for 3 hours. The untreated diseased canes completely failed to germinate. No red rot incidence was observed in plant and ratoon cane grown from the setts treated by MHAT at 54°C for 2, 3 and 4 hours and by HWT at 50°C for 3 hours *in vivo* during the growth period and harvesting of the crop. Moist hot air treatment at 54°C for 2 and 3 hours increased yield significantly compared to other treatments. In heat treated cane, ratoon crop gave higher yield than plant crop.

Key words : Red rot, *Colletotrichum falcatum*, moist hot air treatment, hot water treatment

INTRODUCTION

In Bangladesh sugarcane is jeopardized by more than 39 sugarcane diseases of which red rot caused by Colletotrichum falcatum is considered as major one (Rahman *et al.*,1993). It is reported from preliminary survey that red rot alone is perhaps responsible for 10-15% yield reduction and 100% cane loss in some particular plots due to the disease is not uncommon (Anon.,1979). Some high yielding popular varieties like Isd 5/55, Isd 9/57, Co 419, Co 527, Co 1158, BO 17, BO 34, BO 67, BO 70, Q 69, BS 96 (Isd 15), Isd 17 and Isd 18 have been withdrawn from commercial cultivation due to their susceptibility to red rot (Malek, 1985). Considering the severe loss in yield and run out of the cultivable varieties, the control of red rot is considered to be the most important.

Red rot of sugarcane is mainly seed piece transmissible and largely a systemic disease which has not been controlled through ordinary fungicides (Lewin *et al.*1976).

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However, heat therapy, offers some hope in eliminating the pathogen. Heat therapy as a measure of disease control in sugarcane is well recognised (Agnihotri,1993).At present two types of heat therapy, the hot water treatment (HWT) and moist hot air treatment (MHAT) are available in Bangladesh. Elimination of sett borne infection through heat therapy has been attempted by earlier workers. Hot water treatment of seedcanes at 52^{0}C for 18 min. was found to control red rot with partial success (Joshi,1954). But Srinivasan (1971) reported that hot water treatment is ineffective in eliminating dormant infection of red rot in the nodal region of seed piece. Singh (1973) found that hot air treatment of canes at 54^{0}C for 8 hrs. was effective in controlling red rot. Again Singh *et al.* (1980) reported that moist hot air treatment at 54^{0}C for 2 hrs. with 99% relative humidity resulted effective disease control in the varieties BO 14, BO 17 and BO 54 varying from 68.75 to 100%. In Bangladesh, very little work on long HWT and MHAT in controlling red rot disease has been done. As such, the present study was undertaken to test the efficiency of MHAT and HWT in controlling red rot from seedcane and the results are presented in this paper.

MATERIALS AND METHODS

Red rot infected setts collected from artificially inoculated canes of the susceptible variety Isd 5/55 were used to set up the experiment both in vitro and in vivo in the year 1994. Ten months old standing canes of the variety Isd 5/55 were inoculated with 0.2 ml of spore suspension ($6x10^5$) of a mixed inoculum by hypodermic syringe method at every alternate internode and kept for a month for disease development. After one month, observation was made by splitting open the canes and ensured for red rot development in each internode including the un-inoculated internode. Two buds setts were prepared from each un-inoculated internode having internal red rot symptoms which was also observed in both the cut ends. To kill the red rot pathogen in the sugarcane setts, heat treatment was carried out by thermostatically controlled moist hot air treatment (MHAT) unit manufactured by Bidyut Yantralaya Internatinal Limited Lucknow, India and hot water treatment (HWT) unit (Model 4809; designed by Davy Engineering Co, Australia). The prepared two bud diseased setts were arranged in a row on each rack in the MHAT chamber maintaining 5 cm space between the two racks. MHAT was done at 54^{0}C and above 95% relative humidity for 2, 3 and 4 hours excluding initial heating time to raise the temperature and humidity. The hot water treatment unit is equipped with an automatic temperature control device, functions precisely and records the operations temperature on a circular recording chart and also by a long thermometer as check directly dipped inside the water tank. Before treatment of setts, the temperature was raised to 50^{0}C and kept constant for 15 minutes. Later on, the desired setts for treatment kept in a perforated cage made of wire net and dipped inside the hot water tank.

The treated and untreated setts used as check were divided into two separate lot as per treatment and one lot was directly planted in micro plots (7 x 5 sq.) following RCB design with 3 replications and other lot was used for laboratory experiment. Observation on germination, weight(yield) of cane and on disease incidence from emergence stage till harvest was made and data were recorded. Observations on weight of cane and disease incidence were also recorded in the ratoon crop. In the laboratory, isolations were also made from treated and untreated seed cane to find out the presence of red rot pathogen. For isolations, tissues were drawn from nodes and internodes of the canes, surface

sterilised with 90% alcohol, washed with sterilised water and plated on oat meal agar (Singh *et al.*, 1980). The plates were incubated at 28° C for 10 days and the presence of red rot pathogen was recorded and finally data were calculated.

RESULTS AND DISCUSSION

In the present investigation, it was found that red rot pathogen did not grow from tissue sample of diseased cane on oat meal agar (OMA) medium after moist hot air treatment (MHAT) at 54°C for 3 and 4 hours with above 95% relative humidity. MHAT at 54°C for 2 hours and HWT at 50°C for 3 hours showed 1 and 2% of tissue samples with living pathogen when untreated check recorded 66.75% tissue sample with living pathogen. This indicated that MHAT at 50°C for 3 and 4 hours controlled red rot infection by 100% while it was controlled 98.5% by MHAT at 54°C for 2 hours and 97.0% by HWT at 50 ° C for 3 hours (Table 1). This result is in agreement with the finding of Singh *et al.*, (1980). They reported 100% control of red rot infection in tissue sample of the varieties BO 14 and BO 17 and 92.73% when treated by MHAT at 54°C for 2 hours with above 95% relative humidity. Rahman *et al.* (1994) also found that the external and internal tissues drawn from the red rot infected setts did not yield red rot organism on wet blotter after MHAT at 54°C for 4 hours while untreated setts showed 80 to 100% infection in the tissue sample of the variety Co 1158. Yang (1979) showed that aerated steam treatment (AST) at 52°C for 4 hours could kill *C. falcatum* in naturally infected buds, leaf sheaths and mid ribs, borer tunnels, and inoculated internodes. The principle of control by MHAT and AST is identical as the medium of heat transfer is humidified air. Joshi (1954) reported good control of red rot from cane sett, when treated with hot water at 52°C for 18 minutes.

Table 1. Effect of MHAT and HWT in controlling red rot pathogen and recovery of *C. falcatum* after treatment of infected cane by tissue planting on oat meal agar (OMA) medium *in vitro*

Treatment	Isolation of *C. falcatum* from tissue sample in OMA medium (%)	% of disease control over untreated check
MHAT at 54°C – 2 hours	1.00	98.5
MHAT at 54°C – 3 hours	0.00	100.0
MHAT at 54°C – 4 hours	0.00	100.0
HWT at 50°C – 3 hours	2.00	97.0
Untreated check	66.67	

The untreated diseased canes completely failed to germinate. On the other hand, limited germination was found when the diseased canes were treated by MHAT at 54°C for 2,3 and 4 hours and HWT at 50°C for 3 hours. MHAT at 54°C for 2 and 3 hours increased germination significantly ($P<0.05$) compared to MHAT for 4 hours, HWT at 50° C for 3 hours and treated diseased cane. Moist hot water treatment of diseased cane at 54°C for 2, 3 and 4 hours and HWT at 50°C for 3 hours showed 15.01, 11.33, 3.0 and 4.33% germination respectively and the germination percentage decreased with the

increase of treatment time by MHAT (Table 2). The results are in conformity with the findings of Singh *et al.* (1980). They found 12.5 to 52.8% germination in MHAT treated cane while 0 to 25% germination in untreated diseased cane collected from naturally red rot infected field. Variability in the tolerance of different cultivators to heat treatment and particularly of diseased seed cane also depends on several factors such as age of seed cane, conditions for growing seed cane, cane after planting and even the disease affecting the seedcane (Benda and Recaud, 1978). In the present investigation, red rot infected setts completely failed to germinate. Similar results were also reported on smut infected seed canes treated by MHAT for 2 hours at 54°C and buds carrying smut infection did not germinate.

Table 2. Effect of MHAT and HWT of diseased setts on germination, millable cane, weight (yield) and red rot disease control in plant and ratoon crops of the variety Isd 5/55.

Treatment	Plant crop			Ratoon	
	Germination	Wt. of cane (kg)	Disease incidence	Wt. of cane (kg)	Disease incidence
MHAT at 54°C – 2 hours	15.01	56.50	0	60.17	0
MHAT at 54°C – 3 hours	11.67	42.33	0	49.50	0
MHAT at 54°C – 4 hours	3.00	17.17	0	20.83	0
HWT at 50°C – 3 hours	4.33	14.17	0	17.33	0
Untreated (diseased)	0.00	0.00		0.00	
C. V (%)		34.250		32.830	
S. E. Mean		5.148		5.605	
LSD (0.05)		16.690		18.280	

The crops raised from the treated setts in plant and ratoon crop did not show any red rot incidence in any treatment. This result is in conformity with the finding of Singh *et al.* (1980). They reported no red rot incidence in the crop raised in the field was obtained after MHAT at 54°C for 2 hrs. Significant ($P<0.05$) increase in yield was recorded by MHAT at 54°C for 2 and 3 hours compared to 4 hours and HWT at 50°C for 3 hours. The highest yield was recorded in MHAT at 54°C for 2 hrs. followed by 3 hrs. No significant difference in yield was observed between MHAT at 54°C for 4 hours and HWT at 50°C for 3 hours. In general, ratoon crop yielded higher millable cane than the plant crop (Table 2). This result is in conformity with the findings of Talukder (1994) who reported highly significant increase in yield in ratoon crop than plant crop when crop raised after MHAT of WLD infected setts at 54°C for 2, 3 and 4 hours. From the result, it can be concluded that the treatment of setts by MHAT at 54°C for 3 hours can give effective protection against red rot of sugarcane and thereby enhancing the yield.

It can be concluded from the experiment that moist hot air treatment (MHAT) at 54°C for 2 , 3 and 4 hours with above 95% relative humidity and hot water treatment at 50°C for 3 hours significantly controlled the red rot pathogen from sugarcane setts and the crops grown from the treated setts were free from the disease. MHAT at 54°C for 3 and 4 hours with above 95% relative humidity completely controlled the red rot pathogen while

2 hours treatment with MHAT and HWT at 50°C for 3 hours did not control the pathogen completely. The efficacy of MHAT and HWT varied with the duration and treatment methods. Among all the treatments, MHAT at 54°C for 3 hours with above 95% relative humidity was found effective for disease control, considerable germination and thereby increasing yield of cane in plant and ratoon crop.

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