EVALUATION OF FUNGICIDES FOR CONTROL OF GUMMY STEM BLIGHT OF WATERMELON CAUSED BY *DIDYMELLA BRYONIAE*

M. Z. Rahman[1], M. G. Kibria[2], M. M. R. Talukder[2], M. S. Akhter[3] and M. F. Amin[4]

[1]*Scientific Officer,* [2]*Principal Scientific Officer, RARS, BARI, Rahmatpur, Barishal,*
[3]*Senior Scientific Officer, Plant Pathology Division, BARI, Gazipur,*
[4]*Gender Field Officer, UN Women, Cox's Bazar, Bangladesh.*

ABSTRACT

Rahman, M. Z., Kibria, M. G., Talukder, M. M. R., Akhter, M. S. and Amin, M. F. 2019. Evaluation of fungicides for control of gummy stem blight of watermelon caused by *Didymella bryoniae*. Bangladesh J. Plant Pathol. 35(1&2):47-52

Gummy stem blight (GSB) caused by the fungus *Didymella bryoniae*, is the most destructive disease of watermelon. Nine available commercial fungicides viz. Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, Nativo 75 WG (Tebuconazole + Trifloxystobin) @ 0.1%, Jibal 77 WP (Copper Hydroxide) @ 0.2%, Karishma 28 SC (Azoxystrobin + Cyproconazole) @ 0.2%, Defence 35 SC (Carbendazim + Hexaconazole) @ 0.1%, Aimstar Top 325 SC (Azoxystrobin + Difenoconazole) @ 0.1%, Autostin 50 WDG @ 0.2 %, Filia 525 SE (Tricyclazole + Propiconazole) @ 0.1 %, Secure 600 WG (Fenamidone + Mancozeb) @ 0.2% and Bordeaux mixture (1:1:100) were evaluated as foliar spray to control the disease and to_improve yield during 2016-17 and 2017-18 crop seasons. Control treatments received only water spray. In 2016-17, the maximum percent disease index (PDI) of 46.50% and the lowest yield of 10.94 t/ha was recorded under control. The PDI was reduced to 8.50-19.00% and yield was increased to 12.22-14.72 t/ha due to fungicidal spray. In 2017-18 crop seasons, the PDI was 44.67% and yield was 12.94 t/ha under control. Due to fungicidal spray the PDI was reduced to 6.83-17.83% and yield was increased to 14.60-18.81 t/ha. The most effective fungicide was Nativo 75 WG followed by Aimstar Top 325 SC, Bordeaux mixture (1:1:100) and Karishma 28 SC to control the Gummy stem blight disease and to increase yield of watermelon. Maximum disease reduction (81.72% and 84.71%) and yield (17.98 t/ha and 18.81 t/ha) were obtained when spraying with Nativo 75 WG, followed by Aimstar Top 325 SC. Based on results of the present investigation Nativo 75 WG @ 0.1%, Aimstar Top 325 SC @ 0.1%, Bordeaux mixture (1:1:100) and Karishma 28 SC @ 0.2%, may be recommended against gummy stem blight of watermelon.

Key words: Fungicides, Gummy stem blight (GSB), Watermelon.

INTRODUCTION

Watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai] is an annual creeping plant under the family Cucurbitaceae producing edible fleshy fruits (Robinson and Decker 1997). It is enriching with vitamin A, C. Watermelon is cultivated commercially in Bangladesh and it plays an important role in economic development of farmers (Khanam and Hafsa 2013). It is a summer cash crop and its demand is increasing day by day, (Hoque *et al.* 2015). Various factors affect watermelon production in Bangladesh, but diseases specially Fusarium wilt, gummy stem blight, fruit rots, anthracnose, powdery and downy mildews, bacterial fruit blotch and a number of viruses play vital role. Among the diseases gummy stem blight (GSB), caused by *Didymella bryoniae* (Auersw.) Rehm, is the most common and destructive disease (Keinath 2011). This pathogen is assumed to be distributed worldwide, and can be found in high concentrations in Central and South America, Caribbean, Asia, Africa, Europe and Oceania (CABI 2015). Its results in crown blight, leaf lesions, defoliation, and fruit rot (Sitterly and Keinath 1996). The disease can spread rapidly and cause significant yield reductions of 15-50% under warm, wet conditions in greenhouses and open fields (Arny and Rowe 1991, Schenck 1968, Keinath *et al*. 1995). GSB can cause an average yield loss of 43% in non-sprayed plots (Keinath and Duthie 1998, Keinath and Zitter 1998). Management of GSB requires an integration of both cultural practices and chemical methods; however, cultural practices such as deep turning of plant debris from the previous crop (Keinath 2002), crop rotation with a non-cucurbit host plant, incorporation of cabbage residue followed by soil solarization (Keinath 1996) and avoidance of overhead irrigation that favors the spread of the pathogen have limited effectiveness for GSB management. Resistant varieties are the least expensive, easiest, safest, and most effective means of controlling plant diseases. Genetic resistance to GSB has been identified recently in South Carolina (Sumini *et a*l. 2005) but GSB resistant watermelon cultivars are not yet commercially available (Guras and Wehner 2004).

Frequent application of both protectant and systemic fungicides remains the most effective means of managing GSB. Therefore, growers rely on multiple applications of fungicides to limit yield loss due to the disease. Chemical control is the primary method of managing GSB and several fungicides are available (Sitterly and Keinath 1996, Keinath 2001, Keinath 2011, Keinath and Miller 2014).

In the present study, attempts were made to evaluate the efficacy of currently available nine commercial fungicides to control the GSB fungal pathogens under natural infection and field conditions.

MATERIALS AND METHODS

The experiment was conducted in the Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal during 2016-2017 and 2017-18 crop seasons. The experiment was conducted under natural infection conditions. The experiment was carried out in Randomized Complete Block Design with three replications. Sizes of the plots were 4.0 m x 2.5 m. Variety was used Asian ii (hybrid). Recommended doses of fertilizers (Cow dung 40 Kg, Urea 800 g, TSP 700 g, MoP 1000 g, Zypsum 400 g, Zinc sulphate 5 g, Boric acid 40 g and MgO 50 g per decimal/ 6 pit) were used. Irrigation and weeding were done as and when necessary. Ten fungicides tested in the experiment were Defence 35 SC (Carbendazim + Hexaconazole) @ 0.1%, Aimstar Top 325 SC (Azoxystrobin +Difenoconazole) @ 0.1%, Filia 525 SE (Tricyclazole + Propiconazole) @ 0.1%, Nativo 75 WG (Tebuconazole + Trifloxystobin) @ 0.1%, Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, Jibal 77 WP (Copper Hydroxide) @ 0.2%, Karishma 28 SC (Azoxystrobin + Cyproconazole) @ 0.2%, Autostin 50 WDG (Carbendazim) @ 0.2 %, Secure 600 WG (Fenamidone+ Mancozeb) @ 0.2% and Bordeaux mixture (1:1:100). Three sprays were applied with an interval of 10 days after first disease appearance. Plots under control did not receive any fungicide. Disease Data on disease severity was recorded before every spray using 1-5 rating scale as suggested by Zhang *et al.* (1997) and Zuniga (1999). Percent disease index (PDI) was computed from the final data, percent disease data (PDI) was computed on the basis of the formula according to Krishna Prasad *et al*. (1979) as described below:

$$\text{PDI} = \frac{\Sigma(\text{Class rating X class frequency})}{\text{Total number of leaves counted X maximum rating value}} \text{ X100}$$

Data on number of vines/plant, length of vine/plant, number of fruits/plant, yield/plot were also recorded. Statistical analyses were performed using SAS (Version 9.4) and Microsoft Office Excel 2010. Treatment means were compared via ANOVA using the least significant differences test (LSD) at 5% level.

RESULTS AND DISCUSSION

In fungicidal sprayed plots and under control, the PDI of gummy stem blight (GSB) of watermelon ranged 8.50-46.50% in 2016-2017 and 6.83-44.63% in 2017-2018. In both the year disease severity was the maximum under control. All treatments with fungicides significantly (P=0.05) reduced disease severity (PDI) compared to control in two crop seasons. The lowest PDI was recorded under Nativo 75 WG. The highest disease reduction of GSB was achieved with Nativo 75 WG fungicide followed by Aimstar Top 325 SC, Bordeaux mixture, Karishma 28 SC in both years. The reduction in disease severity was 56.62-81.72% during 2016-2017 and 60.08-84.71% during 2017-2018 (Table 1).

Marketable yield of watermelon ranged 10.96-17.98 and 12.94-18.81 t/ha during 2016-2017 and 2017-2018, respectively. The highest yield was obtained with Nativo 75 WG and the lowest yield was from untreated control plots. All treatments, gave significant increase in yield compared to control during both years. The increase of yield ranged 11.70-64.35 and 12.83-45.36% over control in 2016-2017 and 2017-2018, respectively. Every year, the maximum increase in yield was achieved with Nativo 75 WG followed by Aimstar Top 325 SC, Bordeaux mixture and Karishma 28 SC. The increase in this parameter was higher during 2016-2017 than 2017-2018 (Table 1).

In both seasons of experiment, the relationship of reduction in severity of GSB and marketable yield of watermelon due to fungicidal spray was linear, positive and significant (r=0.938* and r=0.965*). Their relationship could be expressed by the regression equations, Y=1.6668x-59.336 in 2016-17 and Y=1.5288x-59.336 in 2017-18. The coefficient of determination (R^2) indicates that yield increase due to reduction in disease severity may be attributed to 87.95% in 2016-17 and 93.12% in 2017-18 (Fig. 1).

Table 1. Effect of different fungicides on PDI of GSB and fruit yield of watermelon during 2016-17 and 2017-18

Fungicides with dose (%)	2016-2017		2017-2018	
	PDI	Yield (t/ha)	PDI	Yield (t/ha)
Ridomil gold (0.2%)	20.17 b (26.65)	12.22 bc	17.83 b (24.96)	14.60 bc
Nativo (0.1%)	8.50 f (16.94)	17.98 a	6.83 e (15.14)	18.81 a
Jibal (0.2%)	14.00 cde (21.94)	14.45 ab	12.50 bcd (20.67)	16.25 ab
Karishma (0.2%)	13.67 cdef (21.48)	14.58 ab	12.00 cd (20.07)	16.34 ab
Defence (0.1%)	16.67 bcd (24.04)	14.45 ab	14.67 bcd (22.47)	16.06 ab
Aimstar Top (0.1%)	11.67 ef (19.96)	15.28 ab	10.83 de (19.21)	17.13 a
Autostin (0.2%)	19.00 bc (25.81)	13.06 bc	17.23 bc (24.34)	14.68 bc
Filia (0.1%)	18.50 bcd (25.24)	13.19 bc	17.00 bc (24.25)	14.97 bc
Secure (0.2%)	17.67 bcd (24.73)	13.89 bc	16.83 bc (24.07)	15.92 ab
Bodeaux mixture	12.67 def (20.68)	14.72 ab	12.00 cd (20.11)	16.58 ab
Untreated Control	46.50 a (42.97)	10.94 c	44.67 a (41.92)	12.94 c

Figures within parentheses are arc sine transformed values.
Means within the same column with a common letter(s) are not significantly different at 5% level of probability

Table 2. Effect of fungicidal spray on number of vine per plant and vine length of watermelon during 2016-2017 and 2017-2018

Treatments	No. Vines/plant		Average vines/plant	Vine length (cm)		Average vine length (cm)
	2016-2017	2017-2018		2016-2017	2017-2018	
Ridomil gold (0.2%)	3.40 ab	3.33a	3.37	115.68 bc	120.68 bc	118.18
Nativo (0.1%)	3.87 a	4.00a	3.94	145.33 a	145.66 a	145.50
Jibal (0.2%)	3.60 ab	3.67a	3.64	127.56 abc	130.88 abc	129.22
Karishma (0.2%)	3.73 ab	3.67a	3.70	128.68 abc	132.27 abc	130.48
Defence (0.1%)	3.53 ab	3.67a	3.60	123.43 abc	128.60 abc	126.02
Aimstar Top (0.1%)	3.80 ab	3.67a	3.74	142.07 ab	145.40 ab	143.74
Autostin (0.2%)	3.47 ab	3.33a	3.40	116.42 abc	122.83abc	119.63
Filia (0.1%)	3.50 ab	3.33a	3.42	116.83 abc	125.42 abc	121.13
Secure (0.2%)	3.53 ab	3.67a	3.60	122.22 abc	127.22 abc	124.72
Bodeaux mixture	3.73 ab	3.67a	3.70	131.50 abc	132.67 abc	132.08
Untreated Control	3.23 b	3.33a	3.28	111.33 c	114.00 c	112.67

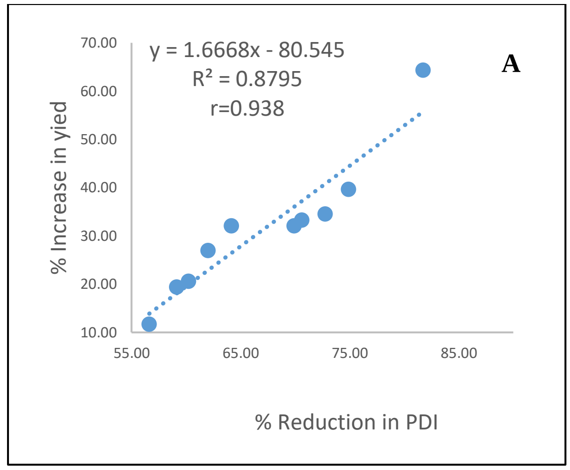
Means within the same column with a common letter(s) are not significantly different (P=0.05).

The data on most important yield contributing parameters such as vine length and number of vines per plant were recorded during 2016-2017 and 2017-2018 crop seasons. Average vine length and number of vines per plant ranged 112.67-145.50 cm and 3.28-3.94 vines/plant, under different treatments including control. Spraying of the diseased field with fungicides caused significant increase in vine length and number of vines per plant over control. Both growth parameters are most important in yield attributes of watermelon. All fungicides gave significant increase in vine length and number of vines per plant compared to control. The highest increase in vine length of 145.50 cm were found under Nativo 75 WG followed by Aimstar Top 325 SC), Bordeaux mixture and Karishma 28 SC. The lowest increase of the parameter was obtained with Ridomil gold MZ 68 WG followed by Autostin 50 WDG (Table 2).

Results of the present experiment reveal that spraying with Ridomil gold MZ 68 WG, Nativo 75 WG, Jibal 77 WP, Karishma 28 SC, Defence 35 SC, Aimstar Top 325 SC, Autostin 50 WDG and Filia effectively reduced GSB severity and substantially increased yield of watermelon. The findings are in agreement with the findings of Thomas *et al*. (2012) and Keinath *et al.* (1999), Vawdrey (1994) and many other workers who reported that the fungicides tebuconazole, fentin hydroxide, prochloraz Mn, benomyl, benomyl plus white oil, propiconazole, mancozeb, mancozeb plus phosphonic acid, myclobutanil and chlorothalonil significantly ($P<0.05$) reduced the incidence and severity of gummy stem blight of watermelon compared to unsprayed control (Vawdrey 1994, Thomas *et al*. 2012). Keinath *et al.* (1999) attributed that Azoxystrobin provided excellent control of gummy stem blight on cucurbit crops.

Alexander and Waldenmeier (2002), Everts and Shields (2000), Keinath (2000), Langston and Seebold (2002) also reported that Chlorothalonil, mancozeb, and strobilurin fungicides are effective to control downy mildew and gummy stem blight and have controlled both diseases. Vawdrey (1994), recorded tebuconazole as the best fungicide to control GSB disease of watermelon and gave the highest yield. Keinath *et al.* (1999) attributed that Azoxystrobin provided excellent control of gummy stem blight on cucurbit crops. Thomas *et al.* (2012) found that GSB of watermelon severity in tebuconazole treated plots were significantly lower than all other treatments and the control.

Based on results of the present investigation it may be concluded that after first disease appearance, three sprays with Nativo 75 WG (Tebuconazole + Trifloxystobin) @ 0.1%, Aimstar Top 325 SC (Azoxystrobin +Difenoconazole) @ 0.1%, Bordeaux mixture (1:1:100) and Karishma 28 SC (Azoxystrobin + Cyproconazole) @ 0.2%, with an interval of 10 days is effective to control gummy stem blight (*Didymella bryoniae*) disease of watermelon.



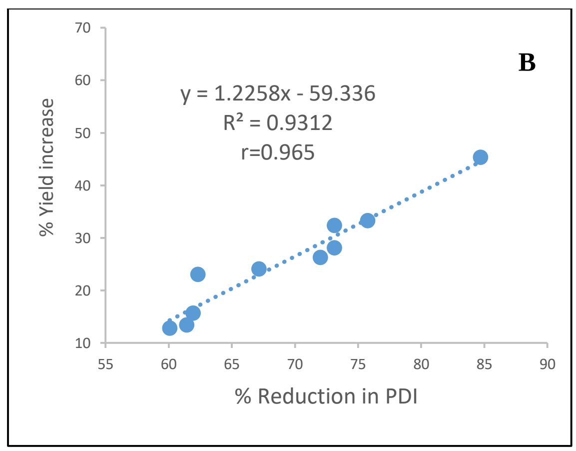


Fig. 1. Relationship of percent yield increase of watermelon with percent reduction of PDI of GSB during 2016-2017 (A) and 2017-2018 (B) crop seasons

LITERATURE CITED

Alexander, S.A. and Waldenmeier, C.M. 2002. Fungicide control of diseases of pickling cucumber experiment 2. Fungic. Nematic. Tests 57, V036 (online). DOI:10.1094/FN57.

Arny, C. J. and Rowe, R. C. 1991. Effects of temperature and duration of surface wetness on spore production and infection of cucumbers by *Didymella bryoniae*. Phytopathology 81:206-209

CABI, 2015. *Didymella Bryoniae* (Gummy Stem Blight of Cucurbits) Datasheet (Full) Report. Crop Protection Compendium (accessed 14.04.16.). www.cabi.org/cpc/.

Everts, K.L. and Shields, P.L. 2000. Evaluation of fungicides for control of gummy stem blight and leaf blight on watermelon. Fungic. Nematic. Tests 55, 287.

Guras, N. and Wehner, T. C. 2004. The genes of watermelon. Hort. Sci. 39:1175- 1182.

Hoque, M. S., Uddin M. F., and Islam M. A. 2015. A market model for watermelon with supply under rational expectations: An empiricals study on Bangladesh. Eur. Sci. J. 11(9):236.

Keinath A. P., Farnham, M. and Zitter, T. 1995. Morphological, pathological, and genetic differentiation of *Didymella bryoniae* and *Phoma* spp. isolated from cucurbits. Phyto pathology 85:364–369.

Keinath, A. 2011. From native plants in Central Europe to cultivate crops worldwide: The emergence of *Didymella bryoniae* as a cucurbit pathogen. Hort. Sci. 46:532-535.

Keinath, A. P. 1996. Soil amendment with cabbage residue and crop rotation to reduce gummy stem blight and increase growth and yield of watermelon. Plant Dis. 80:564-570.

Keinath, A. P. 2001. Effect of fungicide applications scheduled to control gummy stem blight on yield and quality of watermelon fruit. Plant Dis. 85:53-5

Keinath, A. P. 2002. Survival of *Didymella bryoniae* in buried watermelon vines in South Carolina. Plant Dis. 86:32-38.

Keinath, A. P. and Duthie, J. A. 1998. Yield and quality reduction in watermelon due to anthracnose, gummy stem blight and black rot. Pages 77-90 in: Recent Research Developments in Plant Pathology, Vol. 2. Research Signpost, Trivandrum, India

Keinath, A. P., and Miller, G. A. 2014. Watermelon spray guide for 2014. Clemson Cooperative Extension, Clemson, SC.

Keinath, A. P., and Zitter, T. A. 1998. Resistance to benomyl and thiophanate-methyl in *Didymella bryoniae* from South Carolina and New York. Plant Dis. 82:479-484

Keinath, A. P., May, W. and Du Bose, V. 1999. Effects of number of sequential Quadris applications and companion fungicide on foliar disease of watermelon, 1998. Fungic. Nematicide Tests 54:279.

Keinath, A. P. 2000. Effect of protectant fungicide application schedules on gummy stem blight epidemics and marketable yield of watermelon. Plant Dis. 84: 254–260

Khanam, M. and Hafsa, U. 2013. Market model analysis and forecasting behavior of watermelon production in Bangladesh. Bangladesh J. Sci. Res. 26(1&2):47-56.

Krishna Prasad, K. S., Siddaramaih, A. S. and Hedge, R. K. 1979. Development of peanut (Groundnut) rust disease in Karnatake state, India. Plant Dis. Report. 63 (8): 692-695.

Langston, D. B. and Seebold, K.W. 2002. Evaluation of fungicides and biological materials for control of downy mildew and Microdochium blight of pumpkin. Fungic. Nematic. Tests 57, V083 (online). DOI:10.1094/FN57.

Robinson, R. and Decker, W., 1997. Cucurbits. CAB International, Wallingford, Oxon, U.K.

Schenck, N. C. 1968. Epidemiology of gummy stem blight (*Mycosphaerella citrullina*) on watermelon: Ascospore incidence and disease development. Phytopathology 58:1420-1422.

Sitterly, W. R. and Keinath, A. P. 1996. Gummy Stem Blight, p. 27-28. In T. A. Zitter, D. L. Hopkins, and C. E. Thomas (eds.). Compendium of Cucurbit Diseases. APS Press, St. Paul, MN.

Sumini, G., Song, R. and Wehner, T. C. 2005. New sources of resistance to gummy stem blight in watermelon. Crop Sci. 45:582-588.

Thomas, A., Langston, D. B., Jr., Sanders, H. F. and Stevenson, K. L. 2012. Relationship between fungicide sensitivity and control of gummy stem blight of watermelon under field conditions. Plant Dis. 96:1780-1784.

Vawdrey, L. L. 1994. Evaluation of fungicides and cultivars for control of gummy stem blight of rockmelon caused by Didymella bryoniae. Australian J. Experimental Agriculture.34,1191-5

Zhang, Y. M.M., Kyle, K., Anagnostou and Zitter, T.A. 1997. Screening melon (*Cucumis melo*) for resistance to gummy stem blight in the greenhouse and field. Hort. Sci. 32:117–121.

Zúniga, T. L. 1999. Gummy stem blight (*Didymella bryoniae*) of cucurbits: Pathogen characterization and inheritance of resistance in melon (*Cucumis melo*). PhD Diss., Dept. of Plant Pathology, Cornell Univ., Ithaca.