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Effect of biotic and abiotic formulations on control of Botrytis blight of rose *cv.* Grand Gala

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Abstract

The present investigation was undertaken at the Model Floriculture Centre, G. B. Pant University of Agricultural and Technology, Pantnagar. The experiment was conducted to test the different concentrations and time of application of the biotic formulation, *i.e.*, *Bacillus subtilis* var. *amyloliquifaciens* strain FZB24 (manufactured by Novozyme South Asian Pvt. Ltd. under the brand name Taegro) and abiotic formulation *i.e.*, sodium bicarbonate and acetic acid on control of Botrytis blight of rose *cv.* Grand Gala under field conditions and during vase life. A foliar spray of standard chemical Carbendazim 50% W.P. @ 500g/ha, 6 spray at 7 day intervals was found best followed by Carbendazim 50% W.P. @ 500g/ha, 3 sprays at 14 days intervals which was at par with *Bacillus subtilis* @ 1000 g per hectare, 6 sprays at 7 days interval against the incidence of Botrytis blight in field condition while, during vase life, application of treatment was insignificant. Whereas acetic acid and sodium bicarbonate do not significantly affect disease control.

Key words: Rose, Botrytis blight, *Bacillus subtilis*, carbendazim, Grand Gala, biotic, abiotic, formulations

Introduction

Rose (*Rosa species* L.) is acclaimed as the "Queen of flowers" for their exquisite flowers, fascinating colours and most delightful fragrance. Globally, it is the most popular flower in the local and international market for utilization and is top-ranked in trade (Leghari *et al.,* 2016). In addition to their popularity, roses are susceptible to various fungal diseases, which diminish their market value. Botrytis blight, which is caused by the fungus *Botrytis cinerea*, is a significant disease. It is an important pathogen of nursery plants, vegetables and ornamentals, and field and orchard crops that store and transport agricultural products (Elad *et al.,* 2007). Disease development is favoured by periods of cool, cloudy, humid weather. The most peculiar symptom of Botrytis blight is the presence of grayish-brown, fuzzy growth on the surfaces of infected plant parts. The postharvest life of roses depends highly on their susceptibility to *B. cinerea* as its infection reduces the quality, leading to significant economic loss by growers and wholesalers (Vrind, 2005).

Botrytis mould is difficult to control because it has various modes of infection and can survive in crop debris for extended periods. The frequent applications of the most effective fungicides resulted in the selection and predominance of the pathogen-resistant strains. Within a relatively short time, *Botrytis* develops resistance against multiple fungicides (Chen *et al.,* 2016; Fan *et al.,* 2016). Furthermore, environmental and health reasons are increasing concern about the indiscriminate use of chemical pesticides as there is a lack of maximum residual limits for flowers. There is renewed interest in developing alternative control methods, particularly eco-friendly, biodegradable and specific in their action, such as bicarbonates and biofungicides.

Biological control is usually more enduring with no toxic residue in nature's food chain, safe for application and cheaper. Apart from controlling diseases, these bio-control organisms also promote plant growth by producing hormones and increasing nutrient availability (Harman, 2011). *Bacillus subtilis*, which is used to suppress soil-borne diseases caused by *Fusarium* spp., *Rhizoctonia* spp. and *Phytophthora* spp., is also effective against foliar pathogens and acts as a plant growth promoter (Adinarayana *et al.,* 2016). Natural compounds such as inorganic salts and organic acid are used as an alternative method of disease management. Sodium bicarbonate has been reported to control various storage diseases of citrus (Youssef *et al.,* 2012). Hesami *et al.* (2014) also found acetic acid effective against moulds in fruits such as strawberries. Hence, there is immense scope and need to improve the efficacy of botrytis management in rose with eco-friendly and biodegradable alternatives. The present study aimed to determine the effect of *Bacillus subtilis* var. *amyloliquefaciens* strain FZB24 (Taegro) along with sodium bicarbonate, acetic acid and carbendazim on the incidence of Botrytis blight in field conditions and during vase life.

Materials and methods

The experiment was undertaken at the Model Floriculture Centre, G.B. Pant University of Agricultural and Technology, Pantnagar. The rooted cuttings of rose plants (cv. Grand Gala) were planted earlier in the two-row system at 45cm spacing between the rows and plants. Pruning was done at 60-90cm above ground level on 27 October 2016. *B. subtilis* var. *amyloliquifaciens* strain FZB24, manufactured by Novozyme South Asian Pvt. Ltd. under the brand name Taegro was used as bio-formulation.

The experiment was conducted in Randomized Block Design (RBD) with twelve treatments and three replications. The treatments included: T_1: Untreated control, T_2: *B. subtilis* @ 250g/

ha, 6 foliar sprays at 7 days intervals, T_3: *B. subtilis* @ 500g/ha, 6 foliar sprays at 7 days interval, T_4: *B. subtilis* @ 1000g/ha, 6 foliar sprays at 7 days interval, T_5: Carbendazim 50% W.P. @500g/ha, 6 foliar sprays at 7 days interval, T_6: *B. subtilis* @ 250g/ha, 3 foliar sprays at 14 days interval, T_7: *B. subtilis* @ 500g/ha, 3 foliar sprays at 14 days interval, T_8: *B. subtilis* @ 1000g/ha, 3 foliar sprays at 14 days interval, T_9: Carbendazim 50 % W.P. @ 500g/ha, 3 foliar sprays at 14 days interval, T_{10}: Sodium bicarbonate @ 1%, 3 sprays at 14 days interval, T_{11}: Acetic acid @ 5%, 3 foliar sprays at 14 days interval and T_{12}: water, 3 sprays at 14 days interval.

The observations about the incidence of Botrytis blight were recorded on five randomly selected plants per plot four times, *i.e.*, 7 days after first (I), third (II), fifth (III) and sixth (IV) sprays by counting the total number of infected flowers to the total number of flowers. Whereas disease incidence in cut stems during vase life was calculated by counting the number of flowers infected to the total number of stems.

Incidence was calculated using the following formula:

Disease incidence (%) = (Number of infected flowers/Total number of flowers) x 100

The data was statistically analyzed using computer software S.T.P.R. developed by G.B. Pant University of Agriculture and Technology, Pantnagar.

Results and discussion

Effect of biotic and abiotic formulations on the incidence of Botrytis blight of rose under field condition: The first occurrence of the disease was documented, and subsequent incidents were monitored 15 days later (Table 1). The study focused on evaluating the effectiveness of multiple spray treatments in managing Botrytis blight. In the initial observation, conducted seven days after the first spray, disease incidence varied from 46.22 to 87.40%. Notably, Treatment T5, which involved a foliar spray of Carbendazim 50% W.P. at 500 g/ha with six sprays at seven-day intervals, demonstrated the lowest disease incidence at 46.22%. This was statistically comparable to T9, T3, and T4, which had incidences of 49.96, 56.03, and 57.50%, respectively. In contrast, the untreated control (T1) exhibited the highest disease incidence at 87.40%.

Consistent trends were observed after the third, fifth, and sixth sprays. In the second observation, the range of disease incidence was 40.18 to 70.55%. T5 consistently minimized disease incidence at 40.18%, similar to the results for T9, T3, T7, and T8. The highest disease incidence continued to be in T1. This pattern persisted in the third and fourth observations, highlighting T5's reliable efficacy in reducing disease.

Furthermore, the Percent Disease Control (PDC) assessed after the sixth and final spray identified T5 as the most effective, achieving a 53.93% disease control rate. Following T5 were T9, T4, and T3 with disease controls of 41.52, 40.81 and 27.84%, respectively. The application of Carbendazim in T5 likely contributed significantly to this disease control, hindering mycelial growth, as suggested by previous studies by Ram (2009), Shahiduzzaman (2015), Ingram and Meister (2006), and Mousavi *et al.* (2017).

Incidence of Botrytis mould on cut stems of rose: The study investigated the incidence of Botrytis mold on cut rose stems, examining the vase life of stems collected from the treated field and incubated at room temperature (Table 2). Mold incidence was recorded within a range of 33.33 to 66.66%. The analysis indicated that the various treatments applied did not significantly affect the percentage of infected cut stems. However, it was observed that the highest occurrence of infected cut stems (66.66%) was evident in T1 (the untreated control), T10 (involving Sodium bicarbonate foliar spray at 1% with three sprays at 14-day intervals), and T12 (involving water, administered as three sprays at 14-day intervals). In contrast, the lowest incidence of infected stems (33.33%) was documented in T5, where Carbendazim 50% W.P. foliar spray was conducted at 500g/ha, with six sprays at 7-day

Table 1. Effect of biotic and abiotic formulations on incidence of Botrytis blight of rose *cv.* Grand Gala

	Treatment	P.D.I. (I)	P.D.I. (II)	P.D.I. (III)	P.D.I. (IV)	PDC (Terminal point)
T_1	Untreated control	87.40	70.55	55.00	39.18	-
T_2	*Bacillus subtilis* foliar spray @ 250g/ha, 6 sprays at 7 days interval	68.09	59.57	42.21	32.50	17.04
T_3	*Bacillus subtilis* foliar spray @ 500g/ha, 6 sprays at 7 days interval	56.03	47.21	30.00	28.27	27.84
T_4	*Bacillus subtilis* foliar spray @ 1000g/ha, 6 sprays at 7 days interval	57.50	54.66	26.66	23.19	40.81
T_5	Carbendazim 50% WP foliar spray @ 500g/ha, 6 sprays at 7 days interval	46.22	40.18	20.66	18.05	53.93
T_6	*Bacillus subtilis* foliar spray @ 250g/ha, 3 sprays at 14 days interval	75.92	57.44	46.66	35.55	9.26
T_7	*Bacillus subtilis* foliar spray @ 500g/ha, 3 sprays at 14 days interval	66.65	51.39	33.33	29.44	24.85
T_8	*Bacillus subtilis* foliar spray @ 1000g/ha, 3 sprays at 14 days interval	64.81	52.77	38.33	29.10	25.72
T_9	Carbendazim 50% WP foliar spray @ 500g/ha, 3 sprays at 14 days interval	49.96	41.87	24.44	22.91	41.52
T_{10}	Sodium bicarbonate foliar spray @ 1%, 3 sprays at 14 days interval	65.48	57.22	43.33	34.99	10.69
T_{11}	Acetic acid foliar spray @ 5%, 3 sprays at 14 days interval	80.17	61.10	49.99	33.33	14.93
T_{12}	Water, 3 sprays at 14 days interval	86.71	68.14	54.99	35.55	9.26
S.E(m) ±		5.02	4.61	6.67	3.49	-
C.D. at 5 %		14.74	13.61	19.95	10.31	-
C.V		12.98	14.47	30.24	20.06	-

Table 2. Effect of biotic and abiotic formulations on incidence of Botrytis mold on rose *cv.* Grand Gala

Treatments		Percent infected cut stem	PDC
T_1	Untreated control	66.66 (8.11)	-
T_2	*Bacillus subtilis* foliar spray @ 250g/ha, 6 sprays at 7 days interval	50 (6.06)	24.99
T_3	*Bacillus subtilis* foliar spray @ 500g/ha, 6 sprays at 7 days interval	50 (6.06)	24.99
T_4	*Bacillus subtilis* foliar spray @ 1000g/ha, 6 sprays at 7 days interval	50 (6.06)	24.99
T_5	Carbendazim 50% WP foliar spray @ 500g/ha, 6 sprays at 7 days interval	33.33(5.09)	50
T_6	*Bacillus subtilis* foliar spray @ 250g/ha, 3 sprays at 14 days interval	50 (6.06)	24.99
T_7	*Bacillus subtilis* foliar spray @ 500g/ha, 3 sprays at 14 days interval	50 (6.06)	24.99
T_8	*Bacillus subtilis* foliar spray @ 1000g/ha, 3 sprays at 14 days interval	50 (6.06)	24.99
T_9	Carbendazim 50% WP foliar spray @ 500g/ha, 3 sprays at 14 days interval	33.33 (5.09)	50
T_{10}	Sodium bicarbonate foliar spray @ 1%, 3 sprays at 14 days interval	66.66 (8.11)	-
T_{11}	Acetic acid foliar spray @ 5%, 3 sprays at 14 days interval	50 (6.06)	24.99
T_{12}	Water, 3 sprays at 14 days interval	66.66 (8.11)	-
S.E(m) ±		2.24	-
C.D. at 5 %		N.S.	-
	* C.V	60.67	-

* Percent disease control (PDC)
* Figures in parentheses are square root transformed values

intervals, as well as in T9, with Carbendazim 50% W.P. foliar spray at 500 g/ha, administered through three sprays at 14-day intervals.

Maximum control over the mold (50%) was achieved in T5 and T9. In T5, Carbendazim 50% W.P. foliar spray was administered at 500 g/ha, with six sprays occurring at 7-day intervals. Similarly, in T9, the Carbendazim 50% W.P. foliar spray was applied at 500 g/ha but with three sprays at 14-day intervals (Table 2). These results emphasize the effective mold control potential of these treatments.

The study demonstrated the effectiveness of various spray treatments in managing Botrytis blight in roses. Notably, Treatment T5, involving Carbendazim 50% W.P. foliar spray at 500 g/ha with six sprays at seven-day intervals, consistently achieved the lowest disease incidence across observations. Additionally, T9 showcased superior control over Botrytis mold on cut rose stems. These findings underscore the potential of Carbendazim-based treatments in mitigating both blight and mold issues in rose cultivation.

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