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Response of Selected Tomato Germplasm to Different Seed Treatment Methods (Commercial Bleach; Chlorox® and Commercial Fungicide; Thiram) in Control of Damping-off Disease

D. H. S. Komahan, K. Prasannath*
Department of Agricultural Biology, Faculty of Agriculture, Eastern University, Sri Lanka

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***Corresponding author**
K. Prasannath

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Abstract: Seed treatment is an important tool used to protect the germinating embryo and seedling against soil borne damping-off pathogens. Despite the fact that synthetic fungicides are the dominating tool against damping off disease, continued use of these synthetic fungicides causes serious problems including fungicide resistance of the disease causing organisms, contamination of environment and adverse effects on other microbial communities. In this aspect, response of selected tomato germplasm to an alternative strategy; a method of seed treatment by means of commercial bleach (chlorox®) for reducing the damping-off disease has been tested in this experiment. This pot culture experiment was carried out in a factorial design with two factors, namely the tomato varieties (5 varieties; *Thilina*, *K. C. 01*, *Rajitha*, *Money Maker* and *Platinum 701 F1*) and seed treatments (3 treatments; thiram, chlorox® and control treatment) using three replications at Eastern University, Sri Lanka. Among the varieties tested, chlorox® treated *Rajitha*, *Platinum 701 F1* and *K. C. 01* controlled the damping-off disease as equally-efficient as commercial fungicide, thiram. Clorox® can be used to control the damping-off disease instead of synthetic fungicides which can reduce the development of fungal resistance, adverse high toxicity on other microbial communities and alarming social and environmental issues. In summary, our findings draw attention to the commercial bleach (chlorox®) as a promising new applicant for the control of damping-off in tomato varieties *Rajitha*, *Platinum 701 F1* and *K. C. 01*.
Keywords: Commercial Bleach, Thiram, Tomato varieties, Damping-off.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated and extensively consumed horticultural crops in Sri Lanka with an estimated global production over 120 million metric tons [1]. The annual production of tomato is 91, 967 tons in Sri Lanka which ranked 79th in global production [2]. The persisted importance of tomato as a vegetable is revealed by the large volume of research on nearly all aspects of the crop.

Several diseases have threatened tomato production globally, resulting in large losses, especially in fresh markets. Among the soil borne fungal diseases infecting tomato, damping-off of seedlings is a major constraint to the quality and the quantity of production. Several species of *Fusarium*, *Pythium*, *Rhizoctonia* and *Verticillium* cause this disease [3], [4] by killing the young radicle and the plumule and completely rot the seedlings. Immature tissues of the collar at the ground level are infected and the infected tissues turn out to be soft and water soaked. Eventually the seedlings collapse [5].

Chemical disease control methods are widely being used to control damping-off disease all over the world. Reduction of damping-off disease development have long been relied on synthetic chemical fungicides and these fungicides control the disease by direct fungicidal activity or poisonous derivatives converted by the pathogen or host plant tissue [6]. Even though synthetic fungicides are the most powerful tools against this disease, indiscriminate use of synthetic fungicides causes serious problems including fungicide resistance of the disease causing organisms, contamination of environment and adverse effects on other microbial communities [7], [8]. Several alternative approaches have been investigated to control damping-off disease. Though, none of these substitutes reliably provided complete control of this disease.

Commercial bleach (chlorox®) is an effective tool in eradicating pathogens and it is recommended for treatment of seeds of rice, peppers, tomatoes, cucurbits and other vegetables [9]. Chlorox® contains 5.25% of sodium hypochlorite

(NaOCl), which is a resilient oxidizer with broad spectrum antimicrobial activity. NaOCl ionizes to Na^+ and the hypochlorite ion in equilibrium with hypochlorous acid (HOCl) when dissolves in water. Hypochlorous acid (HOCl) is the active component which destructs the cell membranes, nucleic acids and proteins of microbes by oxidative degradation upon contact [10]. This aids to inactivate and reduce the number potential pathogens below a disease threshold while not decreasing seed lot vigor [11].

Much information is available about the use of commercial bleach as a seed treatment to control fungal diseases in different crops; however, main emphasis here is to determine the response of selected tomato germplasm to seed treatments using commercial bleach and commercial fungicide; thriam and also to check the efficacy of commercial bleach compared to commercial fungicide within the selected tomato germplasm in controlling damping-off disease.

MATERIALS AND METHODS

The present investigation on response of selected tomato cultivars to commercial bleach (chlorox®) seed treatment was tested to explore the effect of sodium hypochlorite on controlling damping-off disease in tomato seedlings. Tomato (*Solanum lycopersicum* L.) varieties; *Thilina*, *K. C. 01*, *Rajitha*, *Money Maker* and *Platinum 701 F1* were used as the test crop varieties. This pot culture experiment was performed at Eastern University, Sri Lanka which is situated in the latitude of 70° 43' N and the longitude of 81° 42' E at an elevation of 7.8 m above mean sea level. The temperature of this area ranges from 30 °C to 32 °C and the mean annual rainfall ranges from 1400 mm to 1680 mm. The soil was collected from a tomato nursery bed infected with damping-off disease at Agronomic farm, Eastern University. Collected soil was immediately transported to the Agricultural Biology Laboratory and 4 kg of sick soil was filled in small sized garden trays. Fifteen tomato seeds from each cultivar were soaked in 1% chlorox® solution (commercial bleach) for 30 minutes and another 15 seeds from each cultivar were treated with thiram 80% WP fungicide (rate of application – 5 g/kg seeds) before sowing. Chlorox®and thiram treated seeds from each variety were sown and each garden tray contained 15 seedlings in 3 rows. Untreated seeds were used as control treatment. A factorial design with two factors was conducted using three replicates. Two factors, namely the tomato varieties (5 varieties; *Thilina*, *K. C. 01*, *Rajitha*, *Money Maker* and *Platinum 701 F1*) and the seed treatments (3 treatments; thiram, chlorox® and control treatment) were tested. The evaluation of varietal response to the chlorox® was done and the efficacy of different seed treatment methods were tested for each variety.

The germination percentage was calculated by using the following formula and data was gathered after the emergence of seedlings.

$$\text{Germination Percentage} = \frac{\text{No. of seeds germinated}}{\text{No. of seeds sown}} \times 100\%$$

The data related to percentage infection was gathered by counting the seedlings with disease symptoms. The following formula was used calculate the percentage infection.

$$\text{Percentage Infection} = \frac{\text{No. of damped off seedlings}}{\text{Total number of germinated seedlings}} \times 100\%$$

Disease severity was assessed and calculated using the following formula and the given scale below.

$$\text{Disease Severity} = \frac{0n0 + 1n1 + 2n2 + 3n3 + 4n4}{N\,(4)} \times 100\%$$

0n0, 1n1, 2n2, 3n3, 4n4 - Number of test plants showing a rating of 1, 2, 3, 4 respectively.
N - Total number of the test plants emerged/germinated.
4 - The highest rating scale.

Scale Description

0 No infection (Healthy seedlings)
1 1 - 25% of seedlings showing girdled stem near soil line.
2 26 - 50% of seedlings showing girdled stem near soil line.
3 51 - 75% of seedlings showing girdled stem near soil line.
4 Above 75% of seedlings showing girdled stem near soil line and/ or damped off seedlings.

As the collected data are non-parametric, arc sign transformation technique was used to normalize the data set. The data were analyzed using ANOVA and the means were separated by DMRT using SAS 9.1.

RESULTS AND DISCUSSION

Table-01: Effect of chlorox® on germination percentage

Treatment	Germination Percentage (%)
Money maker	84.44 a
Platinum 701 F1	82.22 a
K. C. 01	77.78 a
Rajitha	62.22 b
Thilina	20.00 c

Mean values followed by the same letter among the varieties are not significantly different at 5% level.

The Table 1 illustrates the data obtained when different variety seeds were treated with chlorox®. The germination results showed that there was a significant difference ($p<0.05$) in germination percentage among the tomato varieties. The highest germination percentage was observed in the variety *Money maker* (84.44%) which was statistically comparable with the germination percentages of the varieties *Platinum 701 F1* (82.22%) and *K. C. 01* (77.78). This was followed by the variety *Rajitha* with a mean germination of 62.22%. The least germination percentage was recorded in variety *Thilina*.

Table-02: Effect of chlorox®on percentage infection

Treatment	Percentage Infection (%)
Thilina	43.28 a
Money maker	28.33 b
Rajitha	27.46 b
Platinum 701 F1	18.22 c
K. C. 01	17.78 c

Mean values followed by the same letter among the varieties are not significantly different at 5% level.

The results demonstrate that there was a significant difference ($p<0.05$) among the tomato varieties in percentage infection (Table 2). The highest mean percentage infection was recorded in *Thilina* with 43.28%. This was followed by the results obtained from the variety *Money maker* (28.33%) which is statistically comparable with the percentage infection of *Rajitha* (27.46%). *K. C. 01* depicted to be the lowest percentage infection (17.78%) which is on par with the percentage infection of *Platinum 701 F1* (18.22%).

Table-03: Effect of chlorox® on disease severity

Treatment	Disease Severity (%)
Thilina	21.14 a
Money maker	15.44 b
Rajitha	12.78 b
Platinum 701 F1	08.11 c
K. C. 01	07.67 c

Mean values followed by the same letter among the varieties are not significantly different at 5% level.

It is obvious from Table 3 that there was a significant difference ($p<0.05$) in disease severity between the varieties treated with chlorox®. The variety *Thilina* recorded the highest disease severity (21.14%) and this was followed by the variety *Money maker* (15.44%) which was statistically comparable with the disease severity of variety *Rajitha* (8.11%). The least disease severity percentage was recorded in *K. C. 01* (7.67%) which is statistically identical with per cent disease severity of the variety *Platinum 701 F1* (8.11%).

Table-04: Response of selected tomato germplasm to different seed treatment methods on percentage infection

	Thilina	Money maker	Rajitha	Platinum 701 F1	K. C. 01
Control	48.4 a	47.8 a	35.4 a	33.3 a	40.8 a
Thiram	34.3 b	20.4 c	25.9 b	16.8 b	14.5 b
Chlorox®	43.3 a	28.3 b	27.5 b	18.2 b	17.8 b

Means with the same letter are not significantly different at p=0.05 among three seed treatments in a given variety.

It was found that there were significant differences in the percentage infection among different seed treatment methods within each tomato cultivar (Table 4). In variety *Thilina*, there was statistically significant difference between thiram and chlorox® treatments. The percentage infection was higher with the chlorox® seed treatment compared to the thiram application. Therefore, it can be said that thiram controlled the disease incidence significantly in comparison to chlorox®.

Although there was significant difference between the seed treatment methods applied within the variety *Money maker*, thiram the chemical fungicide recorded the least percentage infection compared to chlorox®. Hence it can be mentioned that thiram effectively controlled the damping-off disease with regards to chlorox® in variety *Money maker*.

Variety *Rajitha* recorded statistically identical percentage infection in thiram and chlorox® treatments. Thus, it is evident that chlorox® is as equally-capable as thiram in controlling the damping off disease. A similar pattern of percent infection was observed in the varieties *Platinum 701 F1* and *K. C. 01* where the chlorox® was equally efficient as thiram in controlling the disease.

Table-05: Response of selected tomato germplasm to different seed treatment methods on disease severity

	Thilina	***Money maker***	***Rajitha***	***Platinum 701 F1***	***K. C. 01***
Control	24.8 a	22.5 a	18.7 a	16.6 a	19.8 a
Thiram	14.9 b	10.4 c	11.3 b	6.9 b	6.8 b
Chlorox®	21.1 a	15.4 b	12.8 b	8.1 b	7.7 b

Means with the same letter are not significantly different at p=0.05 among three seed treatments in a given variety.

There were significant differences in disease severity among different seed treatment methods within each tomato cultivar (Table 5). There was significant difference between thiram and chlorox® treatments in variety *Thilina*. Chlorox® seed treated plants showed higher disease severity compared to the plants treated with thiram. Therefore, it could be said with certainly that thiram reduced the disease severity significantly compared to chlorox®.

There was significant difference between the control, thiram and the chlorox® seed treatments. In variety *Money maker*, control recorded the highest disease severity value which was on par with the disease severity value of the plants treated with chlorox®. Thiram the chemical fungicide recorded the least disease severity. Hence, in variety *Money maker*, it can be said that the chemical fungicide controlled the damping-off disease effectively than chlorox®.

The highest disease severity value was observed in control which was statistically different from other treatments in variety *Rajitha*. Plants treated with thiram and chlorox® seed treatments showed statistically comparable disease severity. A similar trend of disease severity values was observed in the varieties *Platinum 701 F1* and *K. C. 01* where the chlorox® was equally efficient as thiram in controlling the disease.

Despite the fact that thiram, the commercial fungicide controlled the disease meritoriously by killing the pathogens, the chlorox® was as equally-capable as thiram in controlling the disease in *Rajitha*, *Platinum 701 F1* and *K. C. 01* varieties. Nonetheless, the varieties *Thilina* and *Money maker* showed a poor response to chlorox® with regard to disease control. Therefore, the variation in the percentage infection and disease severity among the chlorox® treated varieties must have been due to the influence of the host plant resistance of the varieties tested. It is supported by a previous study conducted by [12] reporting that *Thilina* and *Money maker* varieties are susceptible to damping-off disease under the similar climatic conditions. The variation in the disease control between thiram and chlorox® seed treatments among the tomato varieties could be due the interaction effect between variety and seed treatment method.

CONCLUSION

Among the varieties tested, chlorox® treated *Rajitha*, *Platinum 701 F1* and *K. C. 01* controlled the damping-off disease as equally-efficient as commercial fungicide, thiram. Apparently, it can be said that chlorox® can be used to control the damping-off disease instead of synthetic fungicides which can reduce the fungicide resistance of the disease causing organisms, contamination of soil and adverse high toxicity on other microbial communities. Therefore, it could be suggested that the tomato farmers in Batticaloa district, Sri Lanka would cultivate *Rajitha*, *Platinum 701 F1* and *K. C. 01* varieties along with chlorox® seed treatment in order to minimize the damping-off disease problem.

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