Efficacy of Five Plant Extracts against Late Blight Disease of Tomato in Experimental Field

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Abstract
This study was conducted to evaluate the efficacy of five plant extracts at different concentration for managing the late blight disease of tomato in experimental field of University of Rajshahi. The antimicrobial activity of five plant extracts such as Water gourd (*Lagenaria siceraria*), Eucalyptus (*Eucalyptus chamadulonsis*), Garlic (*Allium sativum*), Babla (*Acacia nilotica*) and Black Cumin (*Nigella sativa*) was tested for controlling the late blight disease causing pathogens *Phytophthora infestans*. The number of branching of tomato plant was highest in T_{15} treatment (Black Cumin 5%) and lowest in T_5 (Garlic clove 10%) and T_{13} (Babla leaves 2.5%). The maximum number of late blight affected leaves were found inT_1 (control) and T_6 (Garlic clove (5%) treatments, and minimum in T_{14} (Black Cumin 10%). A highest number of fresh tomato was recorded in T_{14} (Black Cumin 10%) and T_{16} (Black Cumin 2.5%) whereas the lowest performance was observed in T_7 (Garlic clove 2.5%). The highest number of late blight affected rotten tomato was observed inT_{12} (Babla leaves 5%) and the lowest in T_5 (Garlic clove 10%). The yield of tomato (g) was found maximum in T_{15} treatment (Black Cumin 5%) and lowest in T_6 (Garlic clove 5%) treatment.

Key words: Eco-friendly management, Fungicidal activity, Late blight disease, Plant extract, Tomato

Introduction

Tomato is important winter vegetable crop from Solanaceae family and grown worldwide (Tolentino *et al.,* 2011). Tomato (*Lycopersicon esculentum* Mill.) is the second most important vegetable after potato (Gondal *et al.,* 2012). Tomato is very important vegetable for its high nutritive values, antioxidant and curative properties (Sahu *et al.,* 2013). It is also good source of vitamin A, C and E (Gondal *et al.,* 2012). It is native to South America (Sahu *et al.,* 2013). Tomato contains 95.3% of water, 0.07% calcium and niacin, and other compounds which have great importance in metabolic activities of humans (Gondal *et al.,* 2012). Tomato production is more important in recent years due to varied climatic adaptability and high nutritional value (Gondal *et al.,* 2012).

Tomato plant is susceptibility to various diseases caused by different agents such as bacteria, viruses, nematode, fungi and abiotic factors (Sahu *et al.,* 2013). Microbes interact in different ways such as commensalism, endophytism, symbiosis and parasitism (Takken *et al.,* 2010). The yield of tomato is specifically affected by wilt and blight diseases caused by *Fusarium* and *Alternaria*, respectively.

Tomato late blight caused by *Phytophthora infestans* (Mont.) de Bary, is a destructive disease of tomato in many parts of the world. The disease also occurs commonly in potatoes, eggplant, nightshade and occasionally on peppers of the family *Solanaceae* (Stevenson, 1993). Wherever tomatoes are grown in tropics without excess use of fungicides, the disease is commonly present (Griffith *et al.,* 1995). The disease was reported having caused tomato and potato crops losses up to 100% (Shrestha and Shrestha, 1997; Pohronezny *et al.,* 1986; Sherf and Macnab, 1986). In California, United States, late blight appears in all tomato growing areas particularly in sprinkler irrigated fields during prolonged periods of rain and or fog with mild temperatures (Nunez and Voss, 2001). An outbreak of tomato late blight occurred in Ontario, Canada in 1976 (Reyes *et al.,* 1977). Since 1990, severe outbreaks of late blight have been observed in commercial and home garden crops of potato and tomato in the United States and Canada (Rowe *et al.,* 2002).

Sallam *et al.* (2012) observed that *D. stramonium* and *A. sativum* at 5% concentration increased the fruit yield by 76.2% and 66.7% compared to the infected control. The yield differences were observed in fruits harvested from plants sprayed with several plant extracts. Some plant extracts and antagonistic microbes have some growth promotion effect which could increase the yield of the plants (Naing *et al.,* 2013). Apart from this, some bio-pesticides induce disease resistance systems of the plants which lead to healthy growth of the plants and thus better productivity (Naing *et al.,* 2013).Quality improvement and increase in yield is as a result of reduced pests and diseases during growth and fruit development and this has been reported by several authors (Rizvi and Jaffar, 2015).Other plant extracts have been reported to have a growth promotion effect (Culver *et al.,* 2012) resulting to increase tomato yield. Growth promotion effect has also been reported upon using microbial pesticides in managing pests and diseases (Rahman *et al.,* 2014).

In recent years, there has been considerable pressure by consumers to reduce or eliminate chemical fungicides in foods. The use of synthetic chemicals to control pest has been restricted due to their carcinogenicity, teratogenecity, high and acute residual toxicity, hormonal imbalance, long degradation period,

environmental pollution and their adverse effects on food and side effects on humans (Brent and Hollomon, 1998; Dubey *et al.*, 2007; Kumar *et al.,* 2007).

Considering the growing importance of the late blight disease and lack of information on integrated management, the present study was carried out to develop eco-friendly fungicides to manage this disease. There are number of useful agrochemicals that are derived from plants. These compounds may provide useful templates to produce more active agrochemicals with less environmental risk. The presence of antifungal compounds in higher plants has long been recognized as an important factor to disease resistance (Mahadevan, 1982; Singh and Dwivedi, 1987; Kurucheve *et al*., 1997).

Therefore, this research was conducted considering the following objectives,

i) To assess the efficacy of five plant extracts on tomato plant growth (height and branches) and yield, and
ii) To assess the efficacy of plant extracts on the control of late blight disease of tomato in experimental field.

Materials and Methods

Plants having the bioactivity against the fungal diseases were surveyed through survey of literature and published papers. Thereafter, a field survey was conducted to identify the origin, habitat and status of bioactive plants in the campus of University of Rajshahi, Bangladesh. Five most bioactive plants such as Water gourd (*Lagenaria siceraria*), Eucalyptus (*Eucalyptus chamadulonsis*), Garlic (*Allium sativum*), Babla (*Acacia nilotica*) and Black Cumin (*Nigella sativa*) were collected for this experiment.

Plant extract preparation and spray

About 100 gram of plant material was boiled in 1000 ml distilled water (w/v, 1:10) for 45 minutes and then passed through two layers of cheese cloth (Hossain and Hossain, 2012). The extracts were centrifuged at 3000 rpm for 20 minutes and stored in a refrigerator at 4°C until used.

Plant extract was sprayed twice a week in the field with the help of sprayer.

Experimental plot and treatments

This field experiment was carried out at Botanical Pesticides Research Field of the Institute of Environmental Science of University of Rajshahi, Bangladesh during Robi season of 2020. Tomato saplings were planted on 15th January, 2020 in the experimental field. Five plant extracts were applied against late blight causing pathogens (*Phytophthora infestans*) of tomato. The Experimental treatments are T_1- control, T_2 – Water gourd leaves (10%), T_3 – Water gourd leaves (5%), T_4 – Water gourd leaves (2.5%) T_5 – Garlic clove (10%), T_6 - Garlic clove (5%) T_7 –Garlic clove (2.5%), T_8 - Eucalyptus leaves (10%), T_9 – Eucalyptus leaves (5%), T_{10}–Eucalyptus leaves (2.5%), T_{11} – Babla leaves (10%),T_{12} - Babla leaves (5%), T_{13} - Babla leaves (2.5%),T_{14} - Black Cumin (10%), T_{15} - Black Cumin (5%) andT_{16} - Black Cumin (2.5%).

Results and Discussion

During this experiment, the highest plant growth (79.33±2.66 cm) was observed in T_{12} treatment (Babla leaves 5%) and second highest (79.00±2.56 cm) was in T_9 treatment (Eucalyptus leaves 5%) treatment. Plant growth in T_4, T_5, T_6, T_7, T_{11}, T_{13}, T_{14} and T_{16} treatments are statistically similar and lowest growth (56.00±2.30 cm) was found in T_3 (Water gourd leaves 5%).The number of branches was highest (3.00±1.00a) in T_{15} (Black Cumin 5%) and lowest in T_5 - Garlic clove 10% (Table 1).

The maximum number of late blight affected leaves (10.67±1.70) was found in T_6 (Garlic clove 5%) and Control (10.00±1.86), and lowest (4.33±1.24) in T_{16} (Black Cumin 2.5%). The treatment T_9 (Eucalyptus leaves 5%) also showed good protection of tomato leaves (4.67±1.59) from late blight disease (Table 1).

Table 1. Plant height (cm), number of branches and number of late blight affected leaves of tomato

Treatment	Plant height (cm)	No. of branch	No. of affected leaves
T_1- control	69.00±3.11ab	2.33±0.76ab	10.00±1.86ab
T_2 - Water gourd leaves (10%)	68.67±2.84ab	2.33±0.76ab	8.33±1.07abc
T_3 -Water gourd leaves (5%)	56.00±2.30b	2.67±0.76a	7.33±1.44abc
T_4 - Water gourd leaves (2.5%)	75.33±2.71a	2.33±0.76b	8.67±1.24abc
T_5 - Garlic clove (10%)	73.33±2.92a	2.00±0.00b	8.00±1.73abc
T_6 - Garlic clove (5%)	69.67±2.38a	2.67±0.76ab	10.67±1.70aa
T_7 - Garlic clove (2.5%)	71.33±2.66a	2.33±0.76ab	7.33±1.24abc
T_8 - Eucalyptus leaves (10%)	68.67±3.74ab	2.33±0.76ab	6.33±1.07abc
T_9 - Eucalyptus leaves (5%)	79.00±2.56a	2.33±0.76ab	4.67±1.59c
T_{10}- Eucalyptus leaves (2.5%)	67.00±3.73ab	2.33±0.76ab	6.67±0.76abc
T_{11} - Babla leaves (10%)	71.00±3.19a	2.67±0.76ab	5.00±0.00c
T_{12}- Babla leaves (5%)	79.33±2.24a	2.67±0.76ab	5.33±0.76c
T_{13} -Babla leaves (2.5%)	71.33±3.20a	2.00±0.00b	5.67±1.07bc
T_{14} - Black Cumin (10%)	71.00±1.00a	2.00±0.00b	4.67±1.07c
T_{15} - Black Cumin (5%)	77.67±2.27a	3.00±1.00a	4.51±0.86c
T_{16} - Black Cumin (2.5%)	71.67±1.95a	2.00±0.00b	4.33±1.24c

Asrafuzzaman *et al.* (2016) carried out experiment on the effect of different botanical treatments regarding plant height against early blight of tomato caused by *Alternaria solani* and found significant different plant height in T_5(Foliar spray of Neem leaf extract @ 1:3 w/v) than T_7 (Foliar spray of Papaya leaf extract @ 1:3 w/v) and T_6 (Foliar spray of Marigold leaf extract @ 1:6 w/v).

Asrafuzzaman *et al.* (2016) also found that the effect of botanical treatments, T_5 (Foliar spray of Neem leaf extract @ 1:3 w/v) gave the highest number of branches per plant followed by T_7 (Foliar spray of Papaya leaf extract @ 1:3 w/v) and T_6 (Foliar spray of Marigold leaf extract @ 1:6 w/v).
Baka and Rashid, 2016 found that aqueous extract of Babla (*Acacia nilotica*) as a most effective one against the early blight of tomato that reduce the disease severity by 70%.

Yadav *et al*. (2017) found that the effect of garlic extract against late blight of tomato on plant height (56.33 cm) and yield (155.12 q/ha) were promisingly better over control.

Khair and Haggag (2007) found that 2.5% aqueous extract garlic and eucalyptus reduced severity of the late blight of potato by 54.2% and 34.3%, respectively.

Amienyo *et al.* (2017) showed that garlic extract reduce the intensity of late blight of potato by 47%.

Ibrahim (2006) found that garlic and black cumin reduce the early blight disease severity by 67.5% and 25% accordingly.
In this study, the highest number of fresh tomato (7.67±1.52) was recorded in T_{14} (Black Cumin 10%) treatment and lowest number (2.33±0.76) in T_7 (Garlic clove 2.5%).The number of late blight affected rotten tomato was maximum (5.33±1.59) inT_{15} (Babla leaves 5%). The highest yield (312.33±8.43 g) of tomato was found in T_{15} (Black Cumin 5%) and lowest yield (69.00±6.88 g) in T_6 - Garlic clove 5% (Table 2).

Table 2. Number of fresh and rotten tomato and yield

Treatment	Number of Fresh Tomato	Number of Rotten Tomato	Total Yield (g)
T_1- control	4.67± 1.59abcde	3.67± 1.59ab	137.67± 8.19cd
T_2 - Water gourd leaves (10%)	3.67± 0.76cde	4.67± 1.44ab	116.33± 6.74cd
T_3 - Water gourd leaves (5%)	3.67± 1.44cde	2.67± 1.44b	124.33± 8.18cd
T_4 - Water gourd leaves (2.5%)	3.67± 0.76cde	3.00± 1.32b	145.67± 4.96cd
T_5 - Garlic clove (10%)	2.67± 1.07de	2.00± 0.00b	79.33± 7.10d
T_6 - Garlic clove (5%)	2.67± 1.07de	4.67± 1.59ab	69.00± 6.88d
T_7 - Garlic clove (2.5%)	2.33± 0.76e	3.67± 0.76ab	72.33± 1.79d
T_8 - Eucalyptus leaves (10%)	3.67± 0.76cde	5.00± 1.73ab	113.67± 5.83cd
T_9 - Eucalyptus leaves (5%)	4.67± 0.76abcde	4.00± 1.41ab	182.67± 7.98abcd
T_{10} - Eucalyptus leaves (2.5%)	4.33± 1bcde.59	3.67± 0.76ab	155.67± 8.80bcd
T_{11} - Babla leaves (10%)	4.00± 1.41cde	3.67± 1.24ab	120.67± 7.63cd
T_{12} - Babla leaves (5%)	6.33± 1.52abc	5.33± 1.59ab	188.33± 9.84abcd
T_{13} - Babla leaves (2.5%)	5.67± 1.75abcd	4.33± 1.59ab	247.00± 10.60abc
T_{14} - Black Cumin (10%)	7.67± 1.52a	4.33± 1.79ab	300.33± 7.38a
T_{15} - Black Cumin (5%)	6.00± 1.41abc	4.53± 1.14ab	312.33± 8.43a
T_{16} - Black Cumin (2.5%)	7.33± 0.76ab	4.33± 1.44ab	288.67± 7.03ab

Asrafuzzaman *et al.* (2016) reported that among the botanical treatments, T_5 (Foliar spray of Neem leaf extract @ 1:3 w/v) gave the highest fresh fruit yield per plant. Botanicals showed significantly better performance than the chemical fungicides. The highest average fruits weight (36.14 g) was recorded in T7 (Foliar spray of Papaya leaf extract @ 1:3 w/v) treatment followed by T6 (Foliar spray of Marigold leaf extract @ 1:6 w/v) and T5 (Foliar spray of Neem leaf extract @ 1:3 w/v), while the lowest average fruits weight (25.61 g) was recorded in T8 (Control). Among the chemical treatments, T3 (Foliar spray of Rovral 50 WP @ 2 g/liter) gave the highest average fruit weight (28.33) followed by T1 (Foliar spray of Bavistin 50 WP @ 1 g/liter) and T2 (Foliar spray of Dithane M-45 @ 4.5 g/liter).

Ahmad *et al.* (2017) observed that garlic extract at 20% concentration was most effective against early blight of tomato caused by *Alternaria solani* both in vitro and in vivo experiments result. In their study, maximum plant height (76.25 cm), fruit size (57.50 cm^3) and yield (511.30 g) were observed in garlic sprayed treatments (20%).

Nashwa (2011) showed that garlic and eucalyptus extract reduced the severity of early blight of tomato by 57.6%, 38.9% and increased yield by 66.7%, 33.3%, respectively at 5% concentration under field conditions.

In an another study, Nashwa *et al*. (2012) found that garlic and eucalyptus extract effective against early blight of tomato at 5% both in greenhouse and filed conditions. The garlic and eucalyptus extract reduced the disease severity by 56.6% and 51.2% and increased yield 66.7% and 47.6%, respectively in field conditions.

Conclusion

The highest plant height of tomato was observed in T_{12} treatment (Babla leaves 5%) and T_9 treatment (Eucalyptus leaves 5%) and more branching was in T_{15} (Black Cumin (5%) treatment. The maximum number of late blight affected leaves was found in T_1 (control) and T_6 (Garlic clove 5%) treatments and minimum in T_{14} (Black Cumin 10%). The maximum number of fresh tomato was observed in T_{14} (Black Cumin 10%) and T_{16} (Black Cumin 2.5%) treatments and highest number of rotten tomato was inT_{12} (Babla leaves 5%). The highest yield of tomato (g) was recorded inT_{15} (Black Cumin 5%) treatment and lowest in T_6 (Garlic clove 5%) treatment.

This study found that three plant extracts (Black Cumin, Garlic clove and Eucalyptus Leaves) are effective to reduce the disease levels of late blight in tomato field. Therefore, these botanicals may be incorporated in tomato field for pest management in eco-friendly way.

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