31st International Conference Ecological Truth & Environmental Research
18–21 June 2024, Hotel Sunce, Sokobanja, Serbia
www.eco.tfbor.bg.ac.rs

# EFFECT OF IRRIGATION RATE ON THE ONSET INTENSITY OF GREY MOULD AND LATE BLIGHT IN GREEN HOUSE TOMATOES

**Gordana Šekularac[1*], Miroljub Aksić[2], Tatjana Dimitrijević[3], Slaviša Gudžić[2], Nebojša Gudžić[2], Dragan Grčak[2], Milosav Grčak[2], Mihailo Ratknić[4]**

[1]University of Kragujevac, Faculty of Agronomy, Cara Dušana 34, 32000 Čačak, SERBIA

[2]University of Priština, Kosovska Mitrovica, Faculty of Agriculture,
Kopaonička nn, 38219 Lešak, SERBIA

[3]Institute of Forestry, Kneza Višeslava 3, 11000 Belgrade, SERBIA

[4]Earthe Climate Change Team (ECCTeam), New Jersey, USA

[*]*gordasek@kg.ac.rs*

## Abstract

*When controlling tomato grey mould and late blight in dependance of irrigation rate, the experiment on fungicide efficiency was made in the greenhouses in 2022. The greenhouses are situated in the village of Batušinac, the municipality of Merošina (south-east Serbia) (43°26'11" N 21°82'28" E). Irrigation rates of 15 mm, 25 mm and 35 mm used for the greenhouse tomato were studied to find out the effect they had exhibited on grey mould and late blight onset intensity. Higher soil moisture at 25 and 35 mm irrigation rates favoured late blight and grey mould, affecting the tomato plants more intensively than being using 15 mm rate. Therefore, lower irrigation rates may efficiently be used as an integral measure of tomato protection from infestation intensity of Phytophthora infestans and Botrytis cinerea.*

**Keywords**: tomato, irrigation, grey mould, late blight.

## INTRODUCTION

Considering that tomato is commercially significant, widespread and usable, no doubt that it ranks among the first vegetable cultures worldwide, particularly in the regions with more suitable soil and climatic conditions for their cultivation, to which Serbia belongs, too [1].

The basic task of watering is to provide sufficient moisture for the agricultural land, which enables normal plant nutrition and growth [1]. In irrigation practice, tensiometer is most commonly used to determine soil moisture. Numerous researchers have confirmed the efficiency of this method when determining irrigation dates of vegetable crops [2,3,4].

When growing tomato under the intensive growing conditions, a whole array of diseases may arise, with an outbreak of *Phytophthora infestans* causing late blight with potato and tomato everywhere in the world where these vegetable crops are grown [5]. This disease is assumed to be one of the most detrimental tomato diseases. It can badly and often utterly damage its plants under suitable growing conditions. Thus, due to the partly or totally destroyed the above-ground plant mass, which looks as if it were burnt by fire, the tomato yield may drastically drop [6].

*Botrytis cinerea* causes grey mould in plants, thereby inflicting serious damages to the production of more than 200 plant varieties, mostly dicotyledon ones [7]. The gravest damages are incurred to grapevine, vegetables, flowers and soft fruits [8,9]. *Botrytis cinerea* may cause huge losses in plants during vegetation, both in fields and greenhouses as well as in the earlier developmental stages of some host plants [10–12]. Thus, the stem rot around the wounds due to sepal breaking is most commonly observed in the tomato grown in plastic and greenhouses whereas the fruits rot accompanied by an extensive pathogen sporulation is mainly detected after the harvest [13].

In essence, the current study was aimed at finding out the way in which a watering rate may cause the outbreak intensity of late blight and grey mould in tomato under the natural infestation conditions as well as at establishing the efficiency level to which the chemicals were used to protect this vegetable from late blight and grey mould.

## MATERIALS AND METHODS

When controlling tomato grey mould and late blight in dependence of watering rate, the experiment on fungicide efficiency was made in the greenhouses in 2022. The greenhouses are situated in the village of Batušinac, the municipality of Merošina (south-east Serbia) (43°26'11" N 21°82'28" E).

Tomato was sown using the hybrid Amati F1 on the 20$^{th}$ of January in the plastic containers placed in the warm garden bed. The transplants were picked in February, the 25$^{th}$ in the pots. Planting in a permanent place in the greenhouse was done on 23$^{rd}$ of March, in the previously marked rows, covered with black polyethylene film, 0.05 mm thick, with irrigation strips placed underneath. Irrigation in the greenhouse was done using a drop-by-drop system.

The effect of irrigation rates on the onset intensity of grey mould and late blight in tomato was studied with the three variants of irrigation rates being: 15 mm, 25 mm and 35 mm. The irrigation moment was determined by tensiometers. Irrigation started at pre-irrigation soil moisture of 30 kPa and stopped at the soil moisture potential of 10 kPa.

The disease onset intensity and fungicide efficiency in controlling tomato late blight and grey rot, was monitored in 600 plants, of which 100 plants pertained to the control variant without chemical protection. The onset intensity of *B. cinerea* was assessed through the division into five classes from 0 to 4 [14], defined as follows:

0 - healthy plants;

1 - up to 25% diseased plants;

2 - from 26% to 50% diseased plants;

3 - from 51% to 75% diseased plants;

4 - from 76% to 100% diseased plants.

After the infestation intensity of *B. cinerea* had been classified, the disease index calculated by the formula of Mc Kinney supposed to indicate the mean value of the disease attacking a particular area (Equation 1),

$$I = \frac{\Sigma(n \times k)}{N \times K} \times 100 \quad (1)$$

was put forth: I – disease index in %, n – plant number within a category, k – number of single categories, N – total plant number and, K – total number of the categories.

Observations for measuring the intensity of *Phytophthora infestans* attacks were carried out by a scoring system 1–9 [15] in Table 1.

The efficiency of fungicides (Table 2) was calculated using the formula of Abbott (Equation 2) being,

$$E=\frac{C-T}{C}\times 100 \quad (2)$$

was put forth: E – efficiency of the fungicide studied, C – plant number on the untreated variant and, T – plant number on the treated variant.

***Table 1*** *Scoring intensity of Phytophthora infestans attacks*

| Score | Percentage of leaves attacked | Description |
|---|---|---|
| 0 | 0 | No symptoms of an attack |
| 1 | <10 | Attack spots are less than 10% in leaves |
| 2 | 11–25 | Spots of damage began to appear and reached 25% |
| 3 | 26–40 | Spots of damage to all leaves reach 40% but the plants are still green |
| 4 | 41–60 | Maximum damage has reached 60% |
| 5 | 61–70 | Maximum damage has reached 70% and the plants changed colour into brown |
| 6 | 71–80 | Maximum damage has reached 80%, the base of the stem and shoots are attacked and the symptoms of wither and death |
| 7 | 81–90 | Maximum damage reaches 90%, the green part is only the top of the leaf |
| 8 | >90 | The green area is low |
| 9 | 100 | There are no more green leaves, the damage is complete |

***Table 2*** *Overview of the fungicides tested*

| Fungicide | Formulation | Active substance | Dose |
|---|---|---|---|
| Nordox 75 | WG | Copper oxide | 2 kg/ha |
| Antracol 70 | WP | Propineb | 2.5 kg/ha |
| Quadris | SC | Azoksistrobin | 0.75 L/ha |
| FolioGold 537.5 | SC | Metalaksil-m (37.5 g/L) + Hlorotalonil (500 g/L) | 2.5–3 L/ha |
| Switch 62.5 | WG | Ciprodinil (375 g/kg) + Fludioksonil (250 g/kg) | 0.6–0.8 kg/ha |
| Dional 500 | SC | Iprodion | 1.5 L/ha |

## RESULTS AND DISCUSSION

Upon visual inspection of the experimental plot, the plants on the control variant without chemical protection were observed to have been infected with late blight. The plants on the variant treated with fungicides were successfully protected from *Phytophthora infestans* and the consequences of late blight largely reduced. On the variant treated with Nordox, <10% of the spots appeared on the leaves at 25 and 35 mm irrigation rates whereas no infestation did at 15 mm (Table 3).

On the variant treated with Antracol, infestation was <10% at 25 mm irrigation rate and *Phytophthora infestans* 11–25% at 35 mm (Table 4).

***Table 3*** *Intensity of Phytophthora infestans attacks on the variant treated with Nordox*

| Irrigation rate (mm) | Percentage of leaves attacked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | <10 | 11–25 | 26–40 | 41–60 | 61–70 | 71–80 | 81–90 | >90 | 100 |
| 15 | - | - | - | - | - | - | - | - | - | - |
| 25 | - | + | - | - | - | - | - | - | - | - |
| 35 | - | + | - | - | - | - | - | - | - | - |

***Table 4*** *Intensity of Phytophthora infestans attacks on the variant treated with Antracol*

| Irrigation rate (mm) | Percentage of leaves attacked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | <10 | 11–25 | 26–40 | 41–60 | 61–70 | 71–80 | 81–90 | >90 | 100 |
| 15 | - | - | - | - | - | - | - | - | - | - |
| 25 | - | + | - | - | - | - | - | - | - | - |
| 35 | - | - | + | - | - | - | - | - | - | - |

The variant treated with Quadris was infected with <10% late blight only at irrigation rate of 35 mm (Table 5).

***Table 5*** *Intensity of Phytophthora infestans attacks on the variant treated with Quadris*

| Irrigation rate (mm) | Percentage of the leaves attacked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | <10 | 11–25 | 26–40 | 41–60 | 61–70 | 71–80 | 81–90 | >90 | 100 |
| 15 | - | - | - | - | - | - | - | - | - | - |
| 25 | - | - | - | - | - | - | - | - | - | - |
| 35 | - | + | - | - | - | - | - | - | - | - |

On the control variant with no fungicides, the tomato plants appeared to have been much more infected with *Phytophthora infestans* than those in the variant treated with fungicides. Also, rather a high disease onset intensity of 41–60% was recorded at 25 and 35 mm irrigation rates whereas a much lower infestation of 11–25% with *Phytophthora infestans*, was manifested at 15 mm (Table 6).

***Table 6*** *Intensity of Phytophthora infestans attack on the control variant without chemical protection*

| Irrigation rate (mm) | Percentage of leaves attacked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | <10 | 11–25 | 26–40 | 41–60 | 61–70 | 71–80 | 81–90 | >90 | 100 |
| 15 | - | - | + | - | - | - | - | - | - | - |
| 25 | - | - | - | - | + | - | - | - | - | - |
| 35 | - | - | - | - | + | - | - | - | - | - |

The higher irrigation rates of 25 and 35 mm and, therefore, a higher soil moisture suited the onset and spreading of late blight, but did not at 15 mm rate. The high moisture level in the greenhouse could suit the disease onset, stimulating spore germination [16,17]. Either an excessive or deficient water use may result in developing many fungal and bacterial plant diseases, which threatens the produce yield and quality [18].

Upon regular visual monitoring of the experimental plot, the symptoms of grey mould appeared on the tomato fruits and on the stem ground part. The tomato preventive and chemical protection was successful in grey mould control. Thus, when irrigated with 15 mm rate, the variants treated with fungicides did not manifest being infested with grey mould whereas those on the control variant with no chemical protection did (8% of the infested plants) (Table 7).

On the variant with 25 mm irrigation rate, 3% accounted for the infected plants treated with Folio Gold whereas the other variants treated with fungicides were not infected with grey rot at all. As for the control variant without chemical protection, 14% accounted for the infected tomato plants.

Further, on the variant with irrigation rate of 35 mm, 5% accounted for the infected plants treated with Folio Gold. The plants on the variants treated with fungicides were not infected whereas 17% of those on the control variant without chemical protection were.

***Table 7*** *Intensity of Botrytis cinerea infection on tomato and efficiency of fungicides*

| Irrigation rate (mm) | Fungicide | Infected plants (%) | Efficiency of fungicides (%) |
|---|---|---|---|
| 15 | Folio Gold 537.5 | - | 100 |
| | Switch 62.5 | - | 100 |
| | Dional 500 | - | 100 |
| | Control | 8 | - |
| 25 | Folio Gold 537.5 | 3 | 78.6 |
| | Switch 62.5 | - | 100 |
| | Dional 500 | - | 100 |
| | Control | 14 | - |
| 35 | Folio Gold 537.5 | 5 | 70.6 |
| | Switch 62.5 | - | 100 |
| | Dional 500 | - | 100 |
| | Control | 17 | - |

The higher irrigation rates (25 and 35 mm), favoured a more serious tomato infection with grey rot in the experimental greenhouse than the lower irrigation rate of 15 mm did. There is a close relationship between the incidence of some diseases and insect pests and the way in which the water is supplied to the tomato plants. The conditions, favouring the majority of diseases are the existence of free water on the leaves and high water content in the soil [19].

The fungicides used to protect tomato from grey rot expressed a high level of efficiency. Thus, Switch and Dional exhibited 100% efficiency on all the irrigation variants. Folio Gold was also 100% efficient on the variants with 15 mm irrigation rate but less efficient (78.6% and 70.6%) on those with 25 mm and 35 mm irrigation rates.

## CONCLUSION

Investigating the onset and infesting intensity of *Phytophthora infestans* and *Botrytis cinerea* in tomato as well as the fungicides efficiency in its protection from all these phytopathogens, resulted in the following conclusions:

- higher soil moisture at 25 and 35 mm irrigation rates favoured a higher outbreak intensity of late blight and grey rot in tomato plants than 15 mm rate did. Therefore, the lower irrigation rates may efficiently be utilized as an integral tomato plants protection measure against the infestation intensity of *Phytophthora infestans* and *Botrytis cinerea*, and

- the successfully performed tomato chemical protection from the *Phytophthora infestans* and *Botrytis cinerea* largely reduced the consequences the infection had on the variants treated with the fungicides compared to the control variant without chemical protection.

## ACKNOWLEDGEMENT

*The authors are grateful to the Ministry of Science, Technological Development and Innovation of the Republic of Serbia for financial support (451-03-66/2024-03/200088; 451-03-65/2024-03/200189 and 451-03-66/2024-03/200027).*

## REFERENCES

[1] Popović M., Povrtarstvo, Nolit, Beograd (1991), p.423, ISBN: 86-19-01891-4.

[2] Smajstrla A.G., Locascio S.J., Appl. Eng. Agr. 12 (1996) 315–319.

[3] Li Y., Rao R., Bryan H., *et al.*, Proc. Fla. State Hort. Soc. 111 (1998) 58–61.

[4] Muñoz-Carpena R., Dukes M.D., Li Y.C., *et al.*, Proc. Fla. State Hort. Soc. 116 (2004) 80–85.

[5] Stojanović S., Poljoprivredna fitopatologija, Srpsko biološko društvo „Stevan Jakovljević", Kragujevac (2004), p.290, ISBN: 86-905643-0-6.

[6] Mijatović M., Obradović A., Ivanović M., Zaštita povrća od bolesti, štetočina i korova, AgroMivas, Smederevska Palanka (2007), p.264, ISBN: 978-86-910485-0-1.

[7] Williamson B., Tudzynski B., Tudzynski P., *et al*., Mol. Plant Pathol. 8 (2007) 561–580.

[8] Droby S., Lichter A., Botrytis: Biology, Pathology and Control, Published by Springer, Dordrecht (2004), p.349–367, ISBN: 978-1-4020-6586-6 (PB), ISBN: 978-1-4020-2624-9 (HB), ISBN: 978-1-4020-2626-3 (e-book).

[9] Tanović B., Pesticidi 18(4) (2003) 223–235.

[10] Giraud T., Fortini D., Levis C., *et al.*, Phytopathology 89 (1999) 967–973.

[11] Chardonnet C.O., Sams C.E., Trigiano R.N., *et al.*, Phytopathology 90 (7) (2000) 769–774.

[12] Staats M., Van Barlen P., Van Kan J.A.L., Mol. Biol. Evol. 22 (2005) 333–336.

[13] Charabany G., Shtienberg D., Plant Dis. 83 (1999) 554–560.

[14] Gudžić S., Praktikum iz fitopatologije, Poljoprivredni fakultet, Univerzitet u Prištini, Kosovska Mitrovica-Lešak (2006), p.160, ISBN: 86-80737-07-0.

[15] Halterman D., Kramer A.L.C., Wielgus S., *et al.*, Plant Dis. 92 (2008) 339–343.

[16] Shtienberg D., Elad Y., Bornstein S., *et al.*, Phytopathology 100 (1) (2010) 97–104.

[17] Becktell M.C., Daughtrey M.L., Fry W.E., Plant Dis. 89(9) (2005) 975–979.

[18] Café-Filho A.C., Lopes C.A., Rossato M., Irrigation in Agroecosystems, IntechOpen, Zagreb (2019), p.184, ISBN: 978-1-78984-924-0, Print ISBN: 978-1-78984-923-3, eBook (PDF) ISBN: 978-1-83881-743-5.

[19] Peerzada S.H., Najar A.G., Mushtaq A., *et al.*, Int. J. Curr. Microbiol. App. Sci. 2(9) (2013) 125–132.