J Biochem Tech (2020) 11 (3): 49-57
ISSN: 0974-2328

Growth Regulators Influence on Fusarium Plant Pathogenic Fungi

Sulukhan Temirbekova*, Elena Kalashnikova, Irina Sardarova, Alla Ovsyankina, Rima Kirakosyan

Received: 28 March 2020 / Received in revised form: 27 July 2020, Accepted: 29 July 2020, Published online: 04 August 2020

Abstract

Agrotechnical methods of grain-crop cultivation require chemical substances to protect the plants from dangerous pests and diseases. However, these measures lead to soil deterioration due to the fungicides and pesticides accumulating in the soil. One of the promising and effective techniques to reduce the deterioration and combat pathogens is using growth regulators. The paper presents the results of a study into the effects of the Krezatsin (concentration of 15, 30 and 60 mg/l), Zircon (concentrations of 0.1, 1 and 10 mg/l) and Appin (concentration of 0.1, 1 and 10 mg/l) growth regulators on the mycelial growth of *Fusarium sporotrichioides* and *Fusarium culmorum*. Screening of the regulators' effect on the *F. culmorum* and *F. sporotrichoides* strains has demonstrated that only Cresacin (concentration of 15 mg/l) and Zircon (all the concentrations) can consistently inhibit mycelial growth, so these growth regulators can be recommended as an effective means to protect grain crops from *Fusarium* L.

Key words: growth regulators; Zircon; Krezatsin; Appin; *Fusarium culmorum; Fusarium sporotrichioides*

Introduction

The health hazards faced by humans from contaminated indoor environments comprise infections, allergies, and toxicity (Al-Rejaboo and Jalaluldeen, 2019). Nowadays, the main goal of a selection program is to increase the yield of a crop by selecting the new cultivars or hybrids that are resistant to both biotic and abiotic stressors since plant diseases spread when the same varieties prevail in a population which leads to incomplete harvest and its poor quality. Insecticides are being used extensively all over the world in the field of agriculture and public health to control insects, weeds, animals, and vectors of the diseases (Kamel and Cherif, 2017). Talking about spring wheat, barley, oat, and other grain crops, in the recent years, they have mostly been suffering from fusariosis, which is caused by the *Fusarium* L. fungi and manifests itself in seed and foot rot, mycotoxin infection, seedless ear, reduced seed quality and plant productivity (Gagkaeva, 2011). The hazard may be both low seed yield and its poor quality. Moreover, the mycotoxins in the seed may harm human and cattle health, reduce systemic immunity, and poison their inner organs (Mansvelt, 2017).

Agrotechnical methods of grain-crop cultivation require chemical substances to protect the plants from dangerous pests and diseases. Plants are the oldest friends of humans and have been the subject of scholarly researches since ancient times due to their anti-microbial activity and therapeutic properties (Ghorbanzadeh et al., 2019). However, these measures lead to soil deterioration due to the fungicides and pesticides accumulating in the soil. For that reason, searching for safe alternative methods to reduce biotic stress is one of the topical issues in horticulture.

One of such perspective approaches that protect soil from deterioration and the plants - from pathogens is using growth regulators that at certain concentrations inhibit pathogenic development in plants. The published data say that intact plant resistance to phytopathogens is related to changes in phenolic metabolism (Kalashnikova, 2016), first hand, to the total soluble phenolic compound capacity. However, in the case of grain crops, this mechanism has not been properly studied, which means the most promising growth regulators having the highest effect on the *Fusarium* L. fungi are yet to be discovered.

Hence, the presented study was designed to investigate the inhibitory effects of the Krezatsin, Zircon, and Appin growth regulators on the mycelial growth of the Fusarium fungi.

Methods

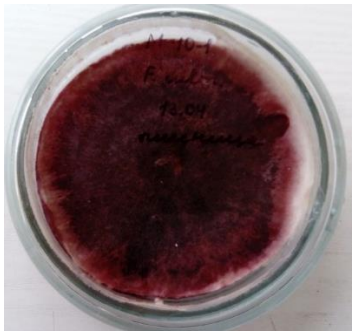
To study the inhibitory effects of the growth regulators, the strains selected from the cultivated plants of wheat, barley, oat, and other grain crops were used. In particular, phytopathogenic fungi *Fusarium culmorum* (strain M1001 selected from wheat in 2009 in the Moscow region and strain M-2-3 selected from barley in 2005 in the Moscow region) and *Fusarium sporotrichioides Sherd* (strain OP-14-1 selected from wheat in 2014 in the Orlov region and strain M 0406 selected from barley in 2006 in the Moscow region) were investigated (see Figure 1).

Sulukhan Temirbekova*, Irina Sardarova, Alla Ovsyankina
All-Russian Research Institute of Phytopathology, Odintsovo, Bolshie Vyazemy, Institute street, 5, 143050, Moscow Region, Russia.

Elena Kalashnikova, Rima Kirakosyan
Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Timiryazevskaya Str., 49, 127550, Moscow Region, Russia.

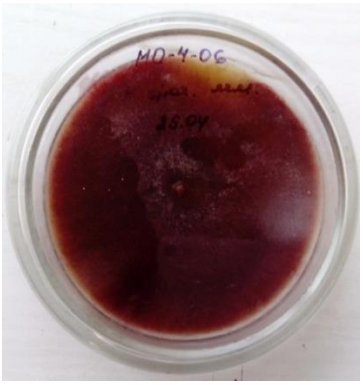
***Email:** sul20 @ yandex.ru

A



B

C



D

Figure 1. Pure fungi culture: A - strain M- 2-3 (*F.culmorum*); B – strain M 1001 (*F.culmorum*); C – strain OP -14-1 (*F.sporotrichioides*), D – strain M 0406 (*F.sporotrichioides*)

The strains were selected and identified at Chair of Mycology of the All-Russian Research Institute of Phytopathology. The pure cultures were continuously stored in a fridge at a temperature of $+4^0$C.

To restore the fungi's functional activity, the strains were passaged in 1/2 strength hormone-free Murashige and Skoog medium (MS ½) to be grown in lightroom (16-hour photoperiod; 25ºC; 3000 lx) (Murashige 1962). Transplantation was performed on days 5-7 in a laminar flow cabinet. All the works, including medium sterilization, were carried out in aseptic conditions using the techniques developed at Moscow Timiryazev Agricultural Academy (Kalashnikova 2014).

The required amounts of the pure fungi cultures were used for screening of the effects the growth regulators had on mycelial growth. The effect of the Krezatsin growth regulator was investigated at a concentration of 15, 30, and 60 mg/l, and that of Zircon and Appin – at 0.1, 1 and 10 mg/l. A culture medium with no growth regulator added was used as a control. Before application, the regulators were sterilized by passing them through a 0.45 - µm bacterial filter (Millipore, see Figure 2).

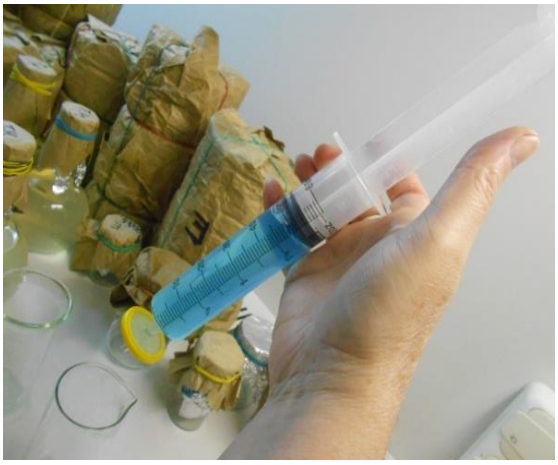
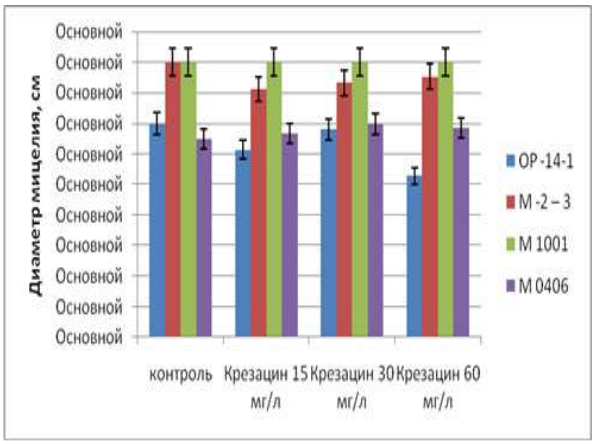


Figure 2. Cold sterilization of the growth regulators.

In a laminar flow cabinet, the obtained sterile solution was added into a previously autoclaved medium, which was then poured in the Petri dishes, 20 ml per dish. The strains of 0.5×0.5 cm in size were placed in the center of each dish to be grown in lightroom (16-hour photoperiod; 25ºC; 3000 lx). The size of mycelium was measured on the seventh day, the whole procedure was repeated 5 times.

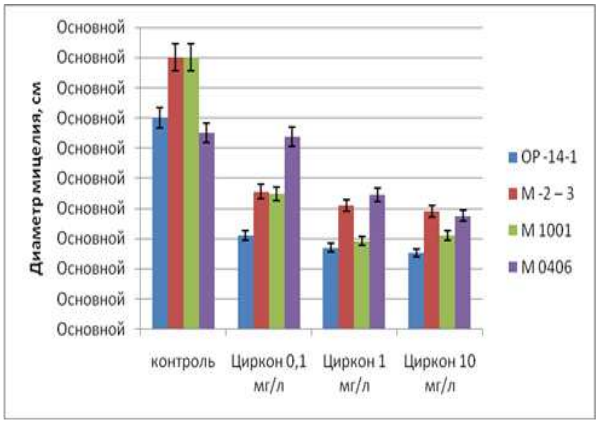
Results

The performed investigation has demonstrated that each regulator (Zircon, Krezatsin, Appin) has a specific effect on certain strains of phytopathogenic fungi and their mycelial growth. The main results are presented in Figures 3 and 4.



Mycelium diameter, cm Main body	Control	Krezatsin, 15 mg/l	Krezatsin, 30 mg/l	Krezatsin, 60 mg/l

Figure 3. Krezatsin and its inhibitory effect on the mycelial growth of different *Fusarium* L. strains.



Mycelium diameter, cm Main body	Control	Zircon, 0.1 mg/l	Zircon, 1 mg/l	Zircon, 10 mg/l

Figure 4. Zircon and its inhibitory effect on the mycelial growth of different *Fusarium* L. strains.

Krezatsin at a concentration of 15mg/l inhibited the mycelial growth of *Fusarium culmorum* (strain M-2-3) and *F. sporotrichoides* (strain OP-14-1) reducing it by 15% if compared to the control. The concentrations of 30 and 60 mg/l also reduced the growth but the reduction degree was insignificant relative to the control. As for the other two strains (M 1001 and M 0406), Krezatsin demonstrated no positive effect, and the obtained measurements were similar to that of the control.

As for Zircon, the regulator had a significant inhibitory effect on the mycelial growth of *Fusarium culmorum* and *Fusarium sporotrichoides* that increased together with its concentration in the medium with the inhibition reaching its maximum at 10 mg/l that reduced the mycelium diameter 2-2.5 times if compared to the control.

Screening of the Appin regulator revealed no correlation dependences between the mycelial growth and the regulator concentration. In all the experiments performed, the mycelium diameter was similar to that in the control, in other words, the Appin regulator had no inhibitory effect on the stressor.

Hence, the tested growth regulators at different concentrations had a species-specific effect on the mycelial growth of phytopathogenic fungi *in vitro*. In terms of their inhibitory effectiveness, the Zircon regulator had the highest rate of success, followed by Krezatsin and Appin.

Conclusions

Thus, the performed screening has demonstrated that out of the three growth regulators tested, only Krezatsin (concentration 15 mg/l) and Zircon (concentration 0.1-10 mg/l) have a stable inhibitory effect on the mycelial growth of the *F. culmorum* and *F. sporotrichoides* strains. These growth regulators can be recommended for the protection of grain crops from the Fusarium fungi.

References

Al-Rejaboo, M. A., & Jalaluldeen, A. M. (2019). Studying the Airborne Fungi of some rooms in the internal sections of Mosul university campus and the Possibility of using Sage plants to control it. *Journal of Advanced Pharmacy Education & Research| Jul-Sep, 9*(3), 17-22.

Gagkaeva T.Yu., Gavrilova O.P., Levitin M.M. et al. (2011). Fusariosis in grain crops. Moscow: Plant protection and quarantine: a collection of articles. 5, pp. 59-120 (in Russian).

Ghorbanzadeh, H. R., Toosi, M. H. B., Sazgarnia, A., Yousefi, M., Bajestani, M. J. N., & Salari, R. (2019). A novel vaporizer to release volatile substances from aromatic plants. *Journal of Advanced Pharmacy Education & Research| Apr-Jun, 9*(S2), 87-92.

Jan Diederik van Mansvelt, & Temirbekova S.K. (2017). Organic agriculture: principles, experience, and perspectives. *Agricultural Biology. 52*(3). pp. 478-486 (in Russian).

Kalashnikova E.A., & Cherednichenko M.Yu. (2016). Biotechnology fundamentals. Moscow: RGAU-MSKhA, 146 pp (in Russian).

Kalashnikova E.A., Cherednichenko M. Yu. Karsunkina N.P. et al. (2014). Laboratory practicum on agricultural biotechnology. Moscow: RGAU-MSKhA, 138 pp. (in Russian).

Kamel, S., & Cherif, A. (2017). The effects of two insecticides" Imidacloprid and Chlorpyrifos" on male quail Coturnix japonica. *International journal of pharmaceutical research and allied sciences, 6*(1), 189-201.

Murashige T., & Scoog F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue culture. Physiol. *Plantarum,* 15, pp. 473–497.