Effect of crop rotation on the incidence of soil-borne fungal wheat pathogens

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Abstract. Nine varieties of soft spring wheat (Altayskaya 70, Altayskaya 75, Krasnoyarskaya 12, Novosibirskaya 15, Novosibirskaya 16, Novosibirskaya 29, Novosibirskaya 31, Novosibirskaya 41 and Svirel) were studied in the field experiment using fallow as a predecessor and wheat as a predecessor both with and without nitrogen fertilizer for an incidence of root infection caused by \textit{Fusarium} spp., \textit{Alternaria} spp. and \textit{Bipolaris sorokiniana}. Average by varieties and variants of experiment incidence of \textit{Fusarium} spp., \textit{Alternaria} spp. and \textit{B. sorokiniana} was 7.5, 5.7 and 10.8\%, respectively. Wheat as a predecessor statistically significantly increased average by varieties incidence of both \textit{Fusarium} spp. and \textit{Alternaria} spp. in comparison with fallow. Nitrogen fertilizer statistically significantly increased average incidence of \textit{Fusarium} spp., \textit{Alternaria} spp. and \textit{B. sorokiniana}. The incidence of fungal root infection and the effects of predecessor and fertilization statistically significantly depended on the variety.

1. Introduction
Among a whole range soil-borne fungal diseases of wheat the most dangerous are the diseases caused by \textit{Fusarium} spp., \textit{Alternaria} spp. and \textit{Bipolaris sorokiniana}. Species of genus \textit{Fusarium} are able to produce a wide range of mycotoxins, including zearalenone, fumonisins B1, deoxynivalenol and T-2 toxin [1], [2], [3]. The most dangerous Alternaria mycotoxins are alternariol, alternariol monomethyl ether, altetroxins, altenuene, tenuazonic acid and tentoxin [4], [5]. \textit{B. sorokiniana} seems to be one of the most destructive wheat fungal pathogen in the warm areas [6]. All these fungi are able to infect roots, stems, leaves and seeds. Treatment with fungicides is effective against seed borne infections, but does not affect the soil borne pathogens [7].

The popular methods for management of soil borne diseases in crop production are crop rotation and soil fertilization [8]. On the other hand, the experimental data about effect of fertilization on plants diseases are contradictory [9].

Previously we demonstrated statistically significant effects of crop rotation and fertilizers on wheat seed contamination with seed-borne Fusarium pathogens [10]. The objective of the present research was to estimate the effects of crop rotation and nitrogen fertilization on the prevalence of root infection of wheat (\textit{Triticum aestivum} L.) caused by \textit{Fusarium} spp., \textit{Alternaria} spp. and \textit{B. sorokiniana}.
2. Methods and results
Nine varieties of soft spring wheat (Altayskaya 70, Altayskaya 75, Krasnoyarskaya 12, Novosibirskaya 15, Novosibirskaya 16, Novosibirskaya 29, Novosibirskaya 31, Novosibirskaya 41 and Svirel) were studied in the field experiment using two crop rotation schemes (fallow as a predecessor; wheat as a predecessor) both with and without nitrogen fertilizer. After harvesting, roots (totally 864 samples) were tested for a presence of fungal infection using Moist Chamber method [10]. Identification of fungi was based on colony characteristics and morphology of the sporulating structures. The incidence of fungi was calculated as a percent of infected roots in a sample. Statistical analysis was performed with StatSoft STATISTICA Version 6.0 statistic software package using Fisher's exact test and Chi-square test.

Average by variants incidences of Fusarium spp., Alternaria spp. and B. sorokiniana varied from 3.1 to 11.5, from 2.1 to 11.5 and from 3.1 to 16.7% depending on the variety. Average by varieties and variants of experiment incidences of Fusarium spp., Alternaria spp. and B. sorokiniana were 7.5, 5.7 and 10.8%, respectively (figure 1).

Wheat as a predecessor statistically significantly (p<0.001) increased average by varieties incidence of Alternaria spp. by 6.7 percentage points (from 2.3 to 9.0%) in comparison with fallow, but had no statistically significant effect on the incidences of Fusarium spp. and B. sorokiniana.

In contrast with predecessor, fertilization statistically significantly increased incidences of all the pathogenic fungi. With no fertilizer average incidence of Fusarium spp., Alternaria spp. and B. sorokiniana was 3.7, 4.2 and 8.1%, respectively. Fertilizing increased average incidence of Fusarium spp. by 7.6 percentage points (p<0.001), average incidence of Alternaria spp. by 3.0 percentage points (p<0.05) and average incidence of B. sorokiniana by 5.3 percentage points (p<0.01).

Effect of fertilizing strongly depended on the crop rotation scheme. With fallow as a predecessor, fertilization increased total incidence of root pathogens by 18.1 percentage points (from 11.6 to 29.6%). In contrast, with wheat as a predecessor, fertilizing increased total incidence of root pathogens by 13.9 percentage points (from 20.4 to 34.3%) (figure 2).

Fertilizing also changed the taxonomic composition of phytopathogenic fungi isolated from wheat roots (figure 3).
Figure 2. Effect of fertilizing on the incidences of *Fusarium* spp., *Alternaria* spp. and *Bipolaris sorokiniana*.

Figure 3. Effect of fertilizing on the taxonomic composition of phytopathogenic fungi isolated from wheat roots.

Both effect of crop rotation scheme and effect of fertilizing strongly depended on the wheat variety (figure 4, figure 5).
**Figure 4.** Effect of crop rotation on the incidences of *Fusarium* spp., *Alternaria* spp. and *B. sorokiniana* in different varieties ("w" – wheat as a predecessor, "f" – fallow as a predecessor).

**Figure 5.** Effect of fertilizing on the incidences of *Fusarium* spp., *Alternaria* spp. and *B. sorokiniana* in different varieties ("no fert" – no fertilizing, "fert" – fertilizing).
3. Conclusion
Our results demonstrate the possibility to control populations of soil borne pathogenic fungi via crop rotation scheme and fertilizing.

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