INFLUENCE OF PLANT POPULATION AND NITROGEN RATE ON OCCURRENCE OF FUSARIUM HEAD BLIGHT ON SOME WHEAT VARIETIES DURING 2013 IN SERBIA

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Abstract: *Fusarium head blight is one of the most important diseases on wheat which can cause numerous types of Fusarium genus. The most significant species that causes Fusarium head blight in USA, Canada and Europe is F. graminearum. The consequences of infection by Fusarium head blight are different, but the most common are reduced yield, physiological and physico-chemical changes of grain and grain mycotoxin contamination. The aim of this study is to test occurrence of natural infection by Fusarium head blight depending on varieties, applied amount of nitrogen (0 kg/ha, 50 kg/ha, 100 kg/ha, 150 kg/ha) from fertilizer of ammonium nitrate (AN 33-35% N) and depending on seeding rate (300 grains/m², 500 grains/m², 700 grains/m², 900 grains/m²). Experiment was set up on Rimski Šančevi, Novi Sad, Serbia, on chernozem soil group. The study included 10 current and perspective varieties of winter wheat and triticale, which were created at the Institute of Field and Vegetable Crops in Novi Sad. Occurrence of Fusarium head blight was tested during the growing season 2012/2013 on nine winter wheat varieties (Arabeska, NS 40S, Zvezdana, NS Desetka, NS Avangarda, NS Futura, NS Ilina, Emina, Enigma) and one triticale variety (Odisej). The evaluation of the intensity of occurrence of infected ears was performed in phenophase of milk and wax maturity of wheat grain. The obtained results were statistically processed in the program Statistica 12 by using analysis of variance and Duncan's multiple range test. Tested varieties had low average number of infected ears by Fusarium head blight on the area of Rimski Šančevi during 2013. Out of ten tested varieties, the highest average number of infected ears had Zvezdana (6.0) and the lowest variety Odisej (1.3). A higher level of correlation between the number of infected ears by Fusarium head blight and seeding rate was established at NS Futura variety. That indicates an increase of the number of infected ears with increasing seeding rate.*
Different amounts of the applied nitrogen for wheat top fertilization showed different effects to the occurrence of Fusarium head blight. The highest average number of infected ears was established at variety Zvezdana with 50 kg/ha of the applied nitrogen from fertilizer of ammonium nitrate. By increasing amounts of nitrogen, the number of infected ears increased at varieties NS 40S, NS Desetka, NS Futura and Enigma.

Key words: *Fusarium head blight, seeding rate, fertilization*

INTRODUCTION

Fusarium head blight is very common disease worldwide. It is one of the most important diseases on wheat which can cause numerous types of *Fusarium* genus. The most significant species that causes Fusarium head blight in USA, Canada and Europe is *F. graminearum* (MCMULLEN et al., 1997). Since 70's of the last century in wheat growing areas of Serbia, Fusarium head blight is limiting factor in wheat production (TEŠIĆ AND STOJANOVIĆ, 1976). The consequences of infection by Fusarium head blight are different, but the most common are reduced yield, physiological and physicochemical changes of grain and grain mycotoxin contamination (LEVIĆ, 2008).

Integral approach, including growing of resistant varieties, applying of suitable agrotechnical measures, efficient chemical control presents the most efficient measure for Fusarium head blight control. Application of agrotechnical measures which contribute to optimal and fast growth of plants during entire vegetation could reduce disease occurrence. Here belongs crop rotation, deeper plowing of harvest residues, watering, optimal timing, deepness and seeding rate (MARIĆ AND JEVTIĆ, 2001).

High concentration of nitrogen often increases sensitivity to diseases (AGRIOS, 1997). LEMMENS et al. (2004) established that increasing of total nitrogen in fertilizers progressively increases symptoms of Fusarium head blight. These authors came to the conclusion that nitrogen affects to intensity of natural occurrence of head blight infection by fungi of *Fusarium* genus. On the contrary, AUFHAMMER et al. (2000) came to the conclusion that fertilizing by nitrogen does not stimulate infection or toxin production by fungi of *Fusarium* genus. Also, TEICH AND HAMILTON (1985), as FAUZI AND PAULITZ (1994) did not recognize influence of nitrogen to occurrence of Fusarium head blight.

By increasing seeding rate increases the number of sprouted plants, level of tillering, number of head blight per square meter, so as yield. Also by increasing seeding rate decreases flowering period (SCHAAFSMA AND TAMBURIĆ-ILINČIĆ, 2005). By decreasing of flowering period index of Fusarium head blight decreases so as the level of mycotoxin DON, which indicates that occurrence of disease is related to uniformity of blooming and indirectly with seeding rate.

The aim of this study is to test occurrence of natural infection by Fusarium head blight depending on varieties, applied amount of nitrogen (0 kg/ha, 50 kg/ha, 100 kg/ha, 150 kg/ha) from fertilizer of ammonium nitrate (AN 33-35% N) and depending on seeding rate (300 grains/m², 500 grains/m², 700 grains/m², 900 grains/m²).

MATERIAL AND METHODS

Experiment was set up on Rimski Šančevi, Novi Sad, Serbia, on chernozem soil group. Type of experiment was three factor (split-split-plot design), in three replications, with a schedule of variants in a randomized block design. The factors were: 1) Varieties, 2) Fertilization and 3) Seeding rate.

Preceding crop of experiment was soybean. Harvested residues were plowed and the tillage and presowing preparation were conventional for all variants of the experiment. The entire surface of the experimental plot was fertilized in the autumn, before the tillage, based on the results of the soil chemical analysis.

Sowing was carried out in optimal agrotechnical term (in the middle of October), with increasing seeding rate (300, 500, 700, 900 germinated seeds m^{-2}). The main plot was 5 m^2. In spring (late February, early March) fertilization of wheat with predicted amounts of nitrogen (0, 50, 100, 150 kg N ha^{-1}) of the ammonium nitrate fertilizer (AN 33-35% N) was carried out.

The study included 10 current and perspective varieties of winter wheat and triticale, which were created at the Institute of Field and Vegetable Crops in Novi Sad. Occurrence of Fusarium head blight was tested during the growing season 2012/2013 on nine winter wheat varieties (Arabeska, NS 40S, Zvezdana, NS Desetka, NS Avangarda, NS Futura, NS Ilina, Emina, Enigma) and one triticale variety (Odisej).

The evaluation of the intensity of occurrence of infected ears was performed in phenophase of milk and wax maturity of wheat grain. It was performed with wooden frame which dimensions are 0.5 x 0.5 m (0.25 m^2), within which the number of infected ears by Fusarium head blight on each plot was visually determined. Occurrence of Fusarium head blight was tested depending on the variety, applied amount of nitrogen and seeding rate.

The obtained results were statistically processed in the program Statistica 12 by using analysis of variance and Duncan's multiple range test.

RESULTS AND DISCUSSIONS

Weather conditions during the period of certain phenophases of wheat significantly affect to the formation and development of Fusarium head blight (WANG, 1997). Heading phenophase corresponds to form and accumulation of ascospores of this pathogen. From heading to flowering, appropriate temperature and relative humidity (RH) affect to the incubation period, or on the length of the period from the beginning of infection by ascospores to occurrence of symptoms (LEVIĆ, 2008).

The conditions that favour the development of Fusarium head blight include temperature range between 20ºC to 30ºC in combination with long humid period during flowering. If leaves after infection are exposed to high air humidity within the period of 18 hours or shorter, symptoms became visible after prolonged latent period (JEVTIĆ et al., 2012). For the realization of ear infection, the time of flowering and grain formation must be during a long humid and warm period with frequent rains and high relative humidity (over 75%) (BALAŽ et al., 1995).

The average monthly temperature for May 2013 was 18.2ºC. In May 2013 amount of precipitation was 118 mm and for June 126 mm (RHMZ, 2013).

During 2011 in Serbia, the tested varieties had low average number of infected ears by Fusarium head blight (MAŠIREVIĆ et al., 2013). As the weather conditions in May and June 2013 did not favour to the development of fungi from *Fusarium* genus, a low number of infected ears was also found on the studied varieties. However, comparison of the varieties was done on the basis of the number of ears infected by Fusarium head blight.

Based upon performed analysis of variance and Duncan's multiple range test it was concluded that statistically, the highest number of infected ears was in varieties Zvezdana and NS Futura. Between these varieties, there were no statistically significant diferences in number of ears infected by Fusarium head blight. Out of ten tested varieties, the highest average number of infected ears had variety Zvezdana (6.0), followed by NS Futura (5.3) and the lowest variety Odisej (1.3). Varieties Enigma and Arabeska had average number of infected ears 5.0; NS Avangarda 3.7; NS Desetka 3.3; Emina 3.0; NS 40S 2.7 and NS Ilina 2.3 with seeding rate of 500 grains/m^2 (Graph 1).

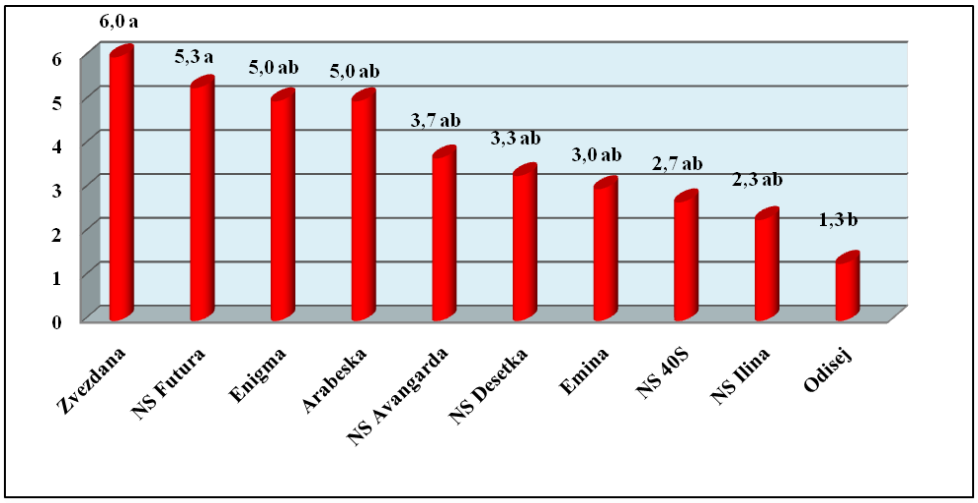

Fig.1 The average number of infected ears on 5 m² in some wheat varieties during 2013

Table 1.

The number of infected ears on 5 m² depending on seeding rate

Varieties	Seeding rate (number of grains/m^2)				Average
	300	500	700	900	
Arabeska	17^{a}	12.3^{abcd}	11.3^{abcd}	13.7^{ab}	13.6
NS Avangarda	6.7^{bcdef}	10^{abcd}	10^{abcd}	9.3^{abcde}	9.0
NS Desetka	7^{bcdef}	5.7^{bcdef}	8^{abcdef}	7.3^{bcdef}	7.0
Emina	9^{abcdef}	12.3^{abcd}	10.3^{abcd}	8.7^{abcdef}	10.1
Enigma	5.7^{bcdef}	7^{bcdef}	11.7^{abcd}	7.7^{bcdef}	8.0
NS Futura	9.3^{abcde}	9.7^{abcde}	13.3^{abc}	13.7^{ab}	11.5
NS Ilina	3.7^{def}	5.3^{bcdef}	8.7^{abcdef}	5.7^{bcdef}	5.9
NS 40S	4.3^{cdef}	6.7^{bcdef}	7.3^{bcdef}	4.7^{bcdef}	5.8
Odisej	0^{f}	0.7^{ef}	0^{f}	0^{f}	0.2

Zvezdana	9.3^{abcde}	6.7^{bcdef}	8^{abcdef}	7^{bcdef}	7.8

In Table 1 is presented number of ears infected by Fusarium head blight on 5 m² in ten studied varieties depending on seeding rate. Applied amount of nitrogen from fertilizer of ammonium nitrate (AN 33-35% N) was 100 kg/ha. The variety Arabeska had the highest average number of infected ears (17) at seeding rate of 300 grains/m² in comparison to other varieties. This variety has had a high average number of infected ears also in other seeding rate. The number of infected ears at seeding rate of 500 grains/m² was 12.3, then 11.3 at seeding rate of 700 grains/m² and 13.7 at seeding rate of 900 grains/m². Varieties Arabeska and NS Futura had the same average number of infected ears with seeding rate of 900 grains/m². Occurrence of Fusarium head blight was recorded at variety Odisej only at seeding rate of 500 grains/m². There was low average number of ears infected by Fusarium head blight (0.7).

A higher level of correlation between the number of infected ears by Fusarium head blight and seeding rate was established at NS Futura variety. That indicates an increase of the number of infected ears with increasing seeding rate.

Table 2.

The number of infected ears on 5 m² depending on nitrogen rate

Varieties	Applied amount of nitrogen (kg/ha)				Average
	0	50	100	150	
Arabeska	5^{abcdefg}	11.7^{efgh}	12.3^{gh}	12.3^{gh}	10.33
NS Avangarda	3.7^{abcde}	4^{abcdef}	10^{cdefgh}	6.7^{abcdefgh}	6.10
NS Desetka	3.3^{abcd}	4.7^{abcdefg}	5.7^{abcdefgh}	8.3^{abcdefgh}	5.50
Emina	3^{abcd}	6^{abcdefgh}	12.3^{gh}	5.7^{abcdefgh}	6.75
Enigma	5^{abcdefg}	6^{abcdefgh}	7^{abcdefgh}	9^{bcdefgh}	6.75
NS Futura	5.3^{abcdefgh}	9.3^{bcdefgh}	9.7^{cdefgh}	12^{fgh}	9.08
NS Ilina	2.3^{abc}	7^{abcdefgh}	5.3^{abcdefgh}	10.7^{defgh}	6.33

NS 40S	2.7^{abcd}	5.3^{abcdefgh}	6.7^{abcdefgh}	7.3^{abcdefgh}	5.50
Odisej	1.3^{ab}	0.3^{a}	0.7^{a}	0.3^{a}	0.65
Zvezdana	6^{abcdefgh}	13.3^{h}	6.7^{abcdefgh}	5.7^{abcdefgh}	7.93

In Table 2 is presented number of ears infected by Fusarium head blight on 5 m² in ten studied varieties depending on nitrogen rate. Seeding rate was 500 grains/m². The highest average number of infected ears was established at variety Zvezdana with 50 kg/ha of the applied nitrogen from ammonium nitrate fertilizer. Variety Zvezdana also had the highest average number of infected ears with 50 kg/ha of the applied nitrogen from ammonium nitrate fertilizer during 2011 (MAŠIREVIĆ et al., 2013).

During 2013, due to increasing amounts of nitrogen, the increase of the number of infected ears was recorded in more varieties. Increase in nitrogen amounts resulted in increase of the number of infected ears at varieties NS 40S, NS Desetka, NS Futura and Enigma. For variety Arabeska was also observed an increase in the number of infected ears at nitrogen rate of 50 kg/ha and 100 kg/ha in comparison to the control, while an equal number of infected ears was recorded with nitrogen rate of 100 kg/ha and 150 kg/ha.

CONCLUSIONS

Based upon the obtained data it can be concluded that on the studied varieties was established low average number of infected ears by Fusarium head blight.

Out of ten tested varieties, the highest average number of infected ears had Zvezdana (6.0) and the lowest variety Odisej (1.3). A higher level of correlation between the number of infected ears by Fusarium head blight and seeding rate was established at NS Futura variety. That indicates an increase of the number of infected ears with increasing seeding rate.

Different amounts of the applied nitrogen for wheat top fertilization showed different effects to the occurrence of Fusarium head blight. The highest average number of infected ears was established at variety Zvezdana with 50 kg/ha of the applied nitrogen from ammonium nitrate fertilizer. During 2013, due to increasing amounts of nitrogen, the increase of the number of infected ears was recorded in more varieties. Increase in nitrogen amounts resulted in increase of the number of infected ears at varieties NS 40S, NS Desetka, NS Futura and Enigma. For variety Arabeska was also observed an increase in the number of infected ears at nitrogen rate of 50 kg/ha and 100 kg/ha in comparison to the control, while an equal number of infected ears was recorded with nitrogen rate of 100 kg/ha and 150 kg/ha.

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Acknowledgement: This work is a result of the research within the project III 43007, 2011-2014, supported by the Ministry of Education and Science, Republic of Serbia.