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Loose smut of barley grown in three types of farming

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Abstract. Over the period of 2014-2015, on the experimental field of the Institute of Agriculture in Karnobat, Bulgaria, was set a field trial with twenty cultivars of barley – 15 two-row: Obzor, Emon, Perun, Orfey, Lardeya, Asparuh, Kuber, Zagorets, Imeon, Sayra, Devinya, Sitara, Krami, Vicky, Potok; 3 four-row: Veslets, Aheloy 2, Tamaris; and 2 six-row cultivars – IZ Bori and Bozhin. All the cultivars were grown in three types of farming: conventional, organic and biodynamic. In conventional farming were applied pesticides and nitrogen fertilization. In the organic production were not used pesticides, mineral and organic fertilizers; and in biodynamic farming was applied biodynamic compost prepared from manure and biodynamic preparations (also organic). In conventional farming, the seeds were disinfected before sowing with Kinto plus (Triticonazole 20 g/l + Prochloraz 60 g/l), at a rate of 150 ml/100 kg seeds. In organic and biodynamic farming were used nondisinfected seeds. In the phenophase of full maturity of barley was conducted monitoring survey for plants infected with loose smut in all the trial variants, the number of infected plants per m² were counted and the infection rates were calculated. Infected plants of Tamaris grown in the three types of farming underwent microscopic analysis and measurement of 100 teliospores from each variant. The aim of this experiment was to investigate varietal susceptibility of barley to *Ustilago nuda*, grown in three types of farming, and to establish if the growing method affects the size of the teliospores of the pathogen. With two-row barley were found plants of Lardeya, Kuber, Devinya, Krami and Vicky infected with *Ustilago nuda*. Krami manifested the lowest resistance in the three types of farming. With four-row barley, Tamaris was found to be highly susceptible and Veslets was poorly resistant. Both cultivars expressed weaker susceptibility in conventional and biodynamic farming and stronger in organic. With six-row cultivars was found no infection. The cultivars of Obzor, Emon, Perun, Orfey, Asparuh, Zagorets, Imeon, Sayra, Sitara, Potok, Aheloy 2, IZ Bori and Bozhin were resistant to *Ustilago nuda* and are suitable to be grown in the three types of farming. The size of teliospores in organic farming exceeded the ones in conventional farming with 5.28%, and the ones in biodynamic farming were smaller with 0.93% on average. The differences were not proven, but the tendency can be explained with the various approaches in growing the crops.

Keywords: *Ustilago nuda*, barley, conventional, organic and biodynamic farming

Introduction

The smuts are some of the most widely spread and harmful diseases on cereal crops. According to Wunderle et al. (2012), in conventional farming loose smut does not stand as a significant problem due to the possibility of effective treatment with fungicides to the seeds. The authors reported that together with the increasing significance of organic farming, where no chemical treatment is allowed and production systems with reduced chemical use are sought in general, there is a renewed interest to seed-transmitted diseases. When using diseased seeds which cannot be distinguished from the healthy ones, the disease colonizes the plants with no visible signs before ear formation. The developed diseased plants form ears, which are fully turned into smutty mass consisting of numerous tiny, ball-shaped fungal teliospores with spikes on the cover. When the seeds are not treated with fungicides, the loss can reach from 5 to 40% (Atanasova et al., 2015). The infestation is directly related to the natural and weather conditions, the degree of resistibility of the regionalized cultivars and the quality of the plant protection measures (Stefanov et al., 1986).

The aim of this experiment was to investigate the varietal susceptibility of barley to loose smut - *Ustilago nuda*, when grown in three types of farming and to establish whether the way of growing affects the size of teliospores of the pathogen.

Materials and methods

Over the period of 2014 – 2015, on the experimental field of the Institute of Agriculture in Karnobat, Bulgaria, was set a field trial with twenty cultivars of barley - 15 two-row: Obzor, Emon, Perun, Orfey, Lardeya, Asparuh, Kuber, Zagorets, Imeon, Sayra, Deviniya, Sitara, Krami, Vicky, Potok; 3 four-row: Veslets, Aheloy 2, Tamaris; and 2 six-row cultivars – IZ Bori and Bozhin. All the cultivars were grown in three types of farming: conventional, organic and biodynamic. Barley varieties were grown on plots of 10 m² in four repetitions - 40 m² of variant in the farming type. In conventional farming were applied pesticides (Secator OD - 10 ml/da - Amidosulfuron 100 g/l + Iodosulfuron 25 g/l + Mefenpyr – diethyl 250 g/l) and sidedressed nitrogen fertilization – N₁₀. In the organic production were not used pesticides, mineral and organic fertilizers; and in biodynamic farming was applied biodynamic compost prepared from manure and biodynamic preparations (also organic). In conventional farming, the seeds were disinfected before sowing with Kinto plus (Triticonazole 20 g/l + Prochloraz 60 g/l), at a rate of 150 ml/100 kg seeds. In organic and biodynamic farming were used nondisinfected seeds. In the phenophase of full maturity of barley was conducted monitoring survey for plants infected with loose smut. In all the trial variants, the number of infected plants per m² were counted in four repetitions and the infection rates were calculated. Infected plants of Tamaris grown in the three types of farming underwent microscopic

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analysis and measurement of 100 teliospores from each variant. Motic BA 300 microscope with camera was used. Analysis of variance was conducted for the variants, whereas checks were used the measurements of teliospores from conventional farming. The weather conditions over the period of barley vegetation were traced.

Results and discussion

The economic year of 2014/2015 was particularly favourable for the development of loose smut of barley - *Ustilago nuda*. After sowing, the temperatures were close to the multi-year values,

whereas precipitation significantly exceeded them (Figure 1). The warm and humid weather stimulated the development of the pathogen in the grain during its germination. In November, the average monthly temperature was 7°C, which slightly exceeded the multi-annual values, but according to Dean (1969) this temperature was favourable and stimulated the development of mycelium of the pathogen. During the whole barley vegetation, the temperatures exceeded the multi-annual values, whereas until May the precipitation was considerably above the norm for the respective months (Figure 1). All these factors benefitted the development of the pathogen. Despite disinfecting the seeds, in conventional farming, infected seeds were found in some of the cultivars (Figure 2).

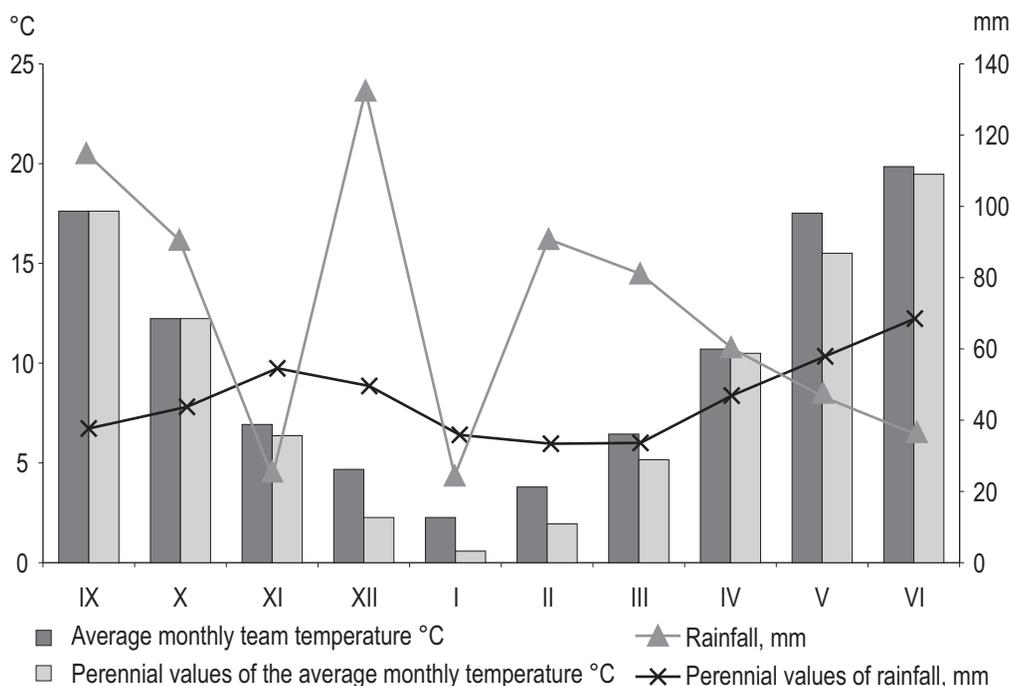


Figure 1. Agrometeorological characteristics of the studied period (2014 - 2015)



Figure 2. *Ustilago nuda* on barley grown in conventional farming

Out of the twenty studied cultivars, plants infected with loose smut of barley - *Ustilago nuda* were only found in seven - five two-row (Lardeya, Kuber, Devinyia, Krami and Vicky) and two four-row (Veslets and Tamaris) (Figure 3).

With Lardeya grown in conventional farming was found no infection. In biodynamic and organic farming, the infection was 5%. The obtained results showed that Lardeya was the most suitable for conventional farming, whereas in biodynamic and organic farming it showed weak susceptibility to the pathogen. With Kuber were found 5% of infected plants in conventional and biodynamic farming, and 7.5% in organic. The cultivar was most resistant in conventional and biodynamic farming and more susceptible in organic farming. In conventional farming, with Devinyia were found 4% of infected plants, and in biodynamic and organic - 7.5%. It showed that the cultivar was most resistant in conventional and more susceptible in biodynamic and organic farming. With Krami the rate of infected plants increased: in conventional farming - 8.3%, in biodynamic - 9%, and 8.5% in organic. The cultivar manifested greater susceptibility in the three types of farming. With Vicky were reported: 6.3% of infected plants in conventional farming, 7.5% in biodynamic, and 6.5% in organic. The cultivar manifested weaker susceptibility in conventional and organic farming and slightly higher in biodynamic. Out of the studied two-row barleys, the weakest susceptibility was shown by Krami in the three types of farming (Figure 3).

With the four-row cultivars, infected plants were only found with Veslets - 5.8% in conventional, 6.5% in biodynamic, and 7% in organic farming; and with Tamaris, which was used as standard of

susceptibility to loose smut, 16.3% in conventional, 24% in biodynamic and 24.5% in organic farming, respectively. With the two cultivars, the lowest rate of infection was established for conventional farming, followed by biodynamic and organic farming (Figure 3), and therefore we can conclude that the two cultivars manifested weaker susceptibility in conventional and biodynamic farming, and stronger – in organic.

The rate of infected plants was lowest in conventional farming

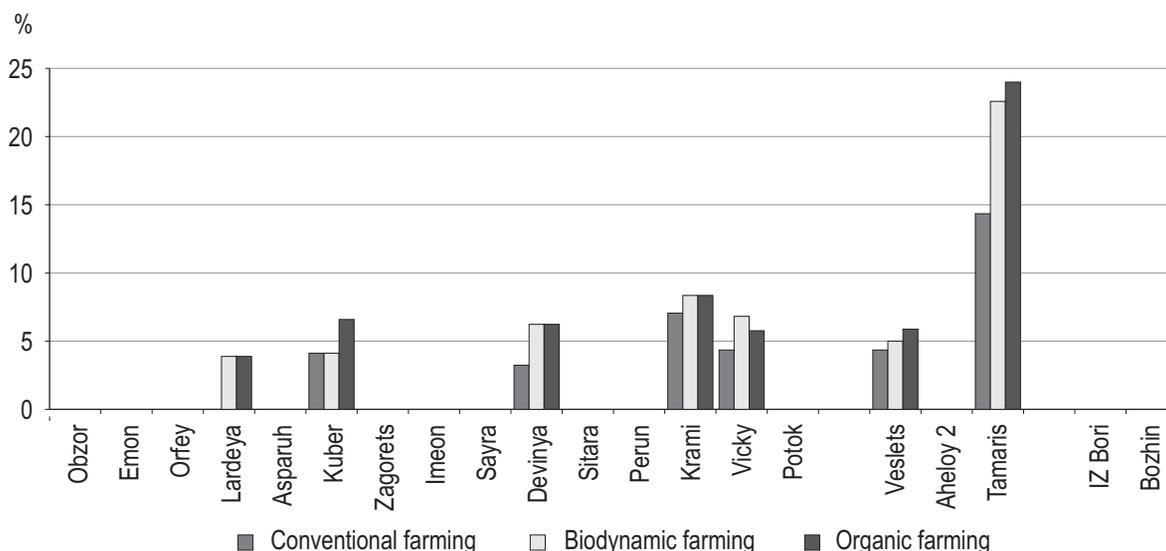


Figure 3. *Ustilago nuda* on the investigated cultivars of barley grown in three types of farming

The rating scale of Tapke determined varieties with up to 10% of infected plants as resistant, and over 10% - as susceptible. According to this assessment scale, only Tamaris gets into the group of susceptible varieties. Microscopic study and measurements were carried out for its teliospores from the three types of farming. As Afanasenko (2009) reported that the size of teliospores of *Ustilago nuda* varies from 3.6 to 9 microns (most frequently within 5.5-6 microns), our aim was to establish whether the type of farming affects their size. Conventional farming was accepted as check due to the fact that it was the most widely spread. After microscopies, measurements and data processing, the following tendency was outlined (Figures 4, 5 and 6) – teliospores from organic farming

for all seven of the susceptible cultivars. This is probably due to disinfection of the seeds before sowing. The greater resistance in biodynamic farming was probably due to the influence of the biodynamic compost and biodynamic preparations on the overall status of the plants and for the increase of its immunity.

With six-row barley were found no infected plants in the three types of farming (Figure 3).

exceeded in size the ones from conventional farming with 5.28%, whereas the ones from biodynamic farming were fewer with 0.93% on average (Figure 7). The differences were not proven but the

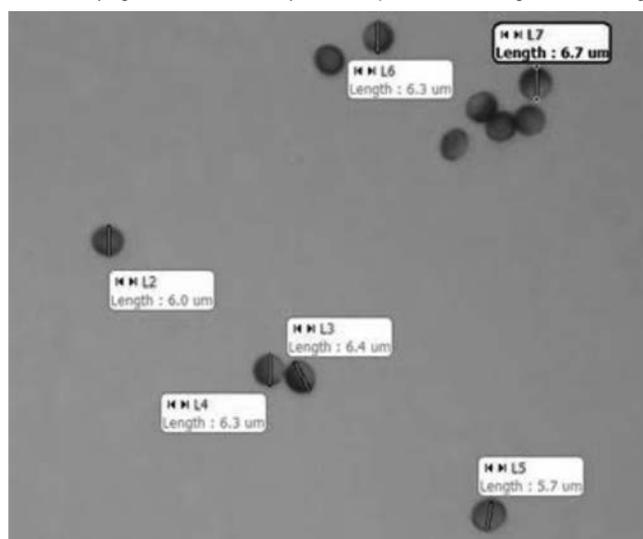


Figure 4. Teliospores of *Ustilago nuda* in conventional farming

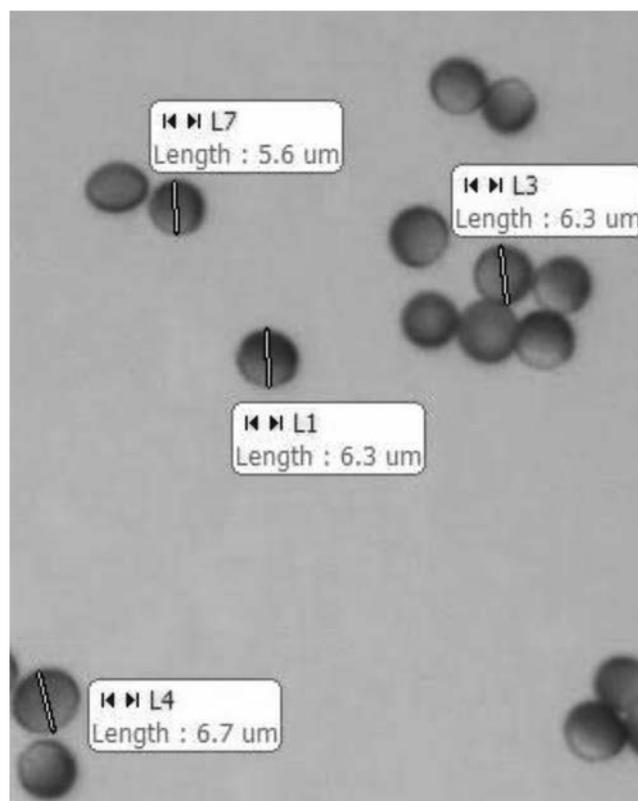


Figure 5. Teliospores of *Ustilago nuda* in biodynamic farming

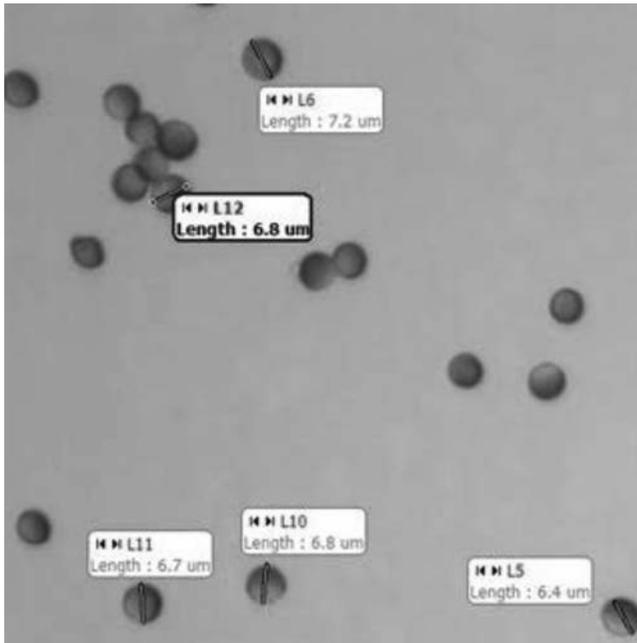


Figure 6. Teliospores of *Ustilago nuda* in organic farming

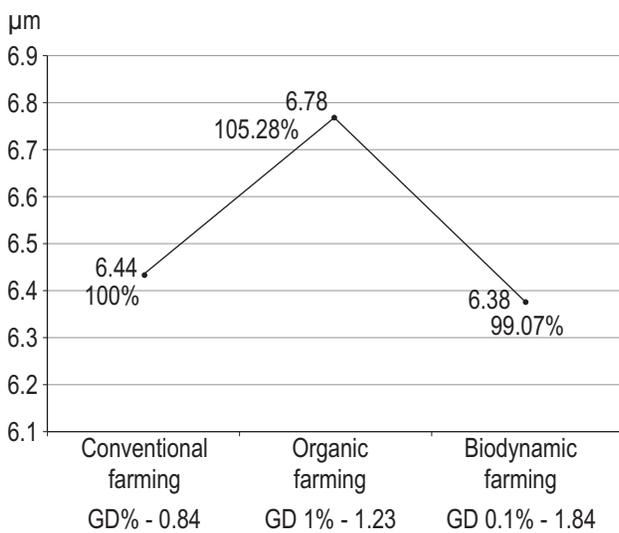


Figure 7. Differences in the size of teliospores of *Ustilago nuda* in three types of farming

tendency can be explained with the different approaches in growing the crop. In conventional farming, which was accepted as check, according to some authors (Snoeijs et al., 2000) nitrogen fertilization increased the risk of infection with pathogens, but the used fungicides for disinfection of the seeds limited and to a great extent eliminated the infection. They also probably affected the size of the teliospores in the pathogen. In organic farming, without application of organic fertilizers, the lack of sufficient amount of nutrients decreased both yield (Seufret et al., 2012) and the plants'

resistance to pathogens (Dordas, 2009). This is probably the reason why the size of teliospores was greatest exactly for this type of farming. In biodynamic farming, the use of organic biodynamic compost probably benefitted the status and immunity of the plants, and thus the smaller size of the teliospores.

Conclusions

With two-row barley were found plants from the cultivars of Lardeya, Kuber, Devinya, Krami and Vicky infected with *Ustilago nuda*. Krami manifested the weakest resistance in the three types of farming. With four-row barley, Tamaris was very susceptible, whereas Veslets was weakly resistant. Both cultivars expressed weaker susceptibility in conventional and biodynamic farming and stronger – in organic. With six-row cultivar was found no infection. The cultivars barley Obzor, Emon, Perun, Orfey, Asparuh, Zagorets, lmeon, Sayra, Sitara, Potok, Aheloy 2, IZ Bori and Bozhin are resistant to *Ustilago nuda* and suitable for growing in the three types of farming. The teliospores from organic farming exceeded in size the ones from conventional farming with 5.28%, whereas the ones from biodynamic farming were smaller with 0.93% on average. The differences were not proven, but the tendency can be explained with the different approaches in growing the crop.

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