# STUDY FOR FUSARIUM HEAD BLIGHT RESISTANCE OF 30 TRITICUM DURUM LINES STORED AT THE ALBANIAN GENEBANK

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## ABSTRACT

Fusarium is an important fungal pathogen that causes Fusarium head blight (FHB) disease on cereals. Several *Fusarium* spp. can cause this disease and they contaminate the kernels with mycotoxins. The present investigation was carried out at the field trial, in the Experimental Station of Agricultural University of Tirana (at geographical coordinates: Longitude: $19^0$ 43"59.90"E, Latitude: $41^0$ 24'04.30"N' and Elevation: 39 m) in 2017. Thirty *Triticum durum* lines and three additional standard lines from Austria were planted: 'Remus', 'DBC4801' and 'Helidur'. There is significant difference between genotypes for the parameter B2. Probability of the Zero Hypothesis (= there is no difference between genotypes) is 0.036, i.e., probability of the Zero Hypothesis is smaller than 0,05 (=5%). A significant difference between genotypes was seen from the results given by statistical analysis for plant height that led to expectations in finding resistant lines showed also by correlation analysis although very week. This material has never been investigated for FHB resistance. The results of this study are valid for wheat genetic improvement programs.
***Keywords***: Fusarium *spp*. resistance, mycotoxins, fungal pathogen

## 1. INTRODUCTION

*Fusarium head blight* (FHB) is economically one of the most serious fungal diseases of wheat in many producing regions of the world (Tomasovic *et al*., 2007). Fusarium head blight (FHB) is an important fungal disease on ears of small grain cereals including Durum wheat worldwide. The Albanian Gene Bank, part of the University of Agriculture, holds approximately 287 accessions of *Triticum durum*. The study of the base collection showed that there is a high genetic diversity of wheat cultivars (Elezi *et al*., 2009).

The best approach to control FHB and to reduce mycotoxin contamination is to create wheat genotypes which are carrying effective resistance genes (Buerstmayr *et al*., 1999; Bai e Shaner 2004; Draeger *et al*., 2007). In general, the causal agents of FHB in Europe are primarily *F. graminearum* (teleomorph *Gibberella zeae*), *F. culmorum* (teleomorph unknown) and *F. avenaceum* (teleomorph *G. avenacea*). In addition, 14 other species have been described as the source of this disease but they play a minor role (Bottalico and Perrone 2002).

Resistance reaction of wheat to *Fusarium* infection includes the following components: Type I, resistance to initial infection (Schroeder and Christensen 1963); Type II, resistance to spread of symptoms (Schroeder and Christensen 1963); Type III, resistance to toxin accumulation (Miller *et al*.,1986); Type IV, resistance to kernel infection (Mesterházy 1995; 1999); Type V, yield tolerance (Mesterházy 1995; 1999). The disease causes yield and quality loss, but the latter caused by the contamination of the seeds with mycotoxins is by far the most important negative effect.

Mycotoxins are secondary metabolites, produced by the fungus and excreted in the plant, that are toxic for animal and man. In general, most *Fusarium* species can produce a cocktail of mycotoxins. For the most important mycotoxins (*e.g.* deoxynivalenol, zearalenone) maximum levels in food and feed are implemented in the EU (Commission Regulation (EC) No 1881/2006). FHB is difficult to control. The fungus survives up to two years in the soil. The pathogen can attack not only small grain cereals, but also maize. Since in general both cereals and maize are grown in a practical crop rotation, control is limited. There are no highly effective fungicides available. Growing wheat cultivars, which are resistant to FHB, is the best solution to control FHB. By increasing the resistance level, the risk for toxin contamination is reduced. Therefore, resistance breeding by introgressing and accumulating resistance factors from different sources are important. To use different resistance genes, a continuous search for new previously unused resistance sources is up most important. Durum wheat (*Triticum turgidum* L. var. durum) is important for human nutrition. Durum wheat is mainly grown in North America as well as in South Europe, West Asia, and North Africa

(Royo *et al*., 2009) and mainly used for high-quality pasta production Durum is one of the most susceptible cereals to infection with FHB due to the lack of resistance sources. Therefore, the current situation in breeding for resistance to FHB Durum wheat is extremely difficult. There is a lack of resistance sources worldwide (Olivera *et al*., 2008; Miedaner and Longin 2014). As a matter of fact, no highly resistant sources comparable to those available in hexaploid wheat have so far been found. Hobdari *et al*., (2017) said that the Albanian Gene Bank has a rich collection of durum wheat, and there are very good conditions for the cultivation of durum wheat (*Triticum durum* Desf.). The studies about the new wheat cultivars in different areas of cultivation in our country have shown significant differences in their adaptation to the eco-climatic conditions of each area (Elezi 2011).

Winter wheat is one of the most important cereal crops in Albania. Kernel diseases of wheat are causing important losses of the yield (Beli *et al*., 2017). Great differences between a thousand kernel weight, yield for all the samples in natural infected and treated cultivars could be noted. No correlation between reduction of TKW and disease index, as well between reduction of yield and disease index (Beli *et. al*., 2017) was found.

As the present investigation aims to find resistant lines against the spreading of the Fusarium head blight disease (Type I resistance), 30 Triticum durum lines were chosen from the Albanian base collection located at the Institute of plant genetic resources (Gene Bank) and 3 commercialized Austrian lines (DBC4801, Remus and Helidur). The Austrian lines are known for they resistance against FHB.

It has been investigated whether characteristics such as plant height and anther extrusion played a role in the disease spreading. This material was never investigated for resistance to FHB. Hence, this collection is extremely attractive to look for new resistance sources. In Albania, climatic conditions such as humidity and warmth are factors that help the disease develop the flowering phase and for a short period after it.

## 2. MATERIALS AND METHODS

*Plant material*: A set of 30 Albanian of Triticum durum and three control lines from Austria were selected. Albanian lines were selected from 287 samples of wheat stored at the Genebank for the investigation of fusarium. This investigation aimed to obtain more complete data on lines that are highly resistant to fusarium (Fusarium Head Blight (FHB)). The plastic bag inoculation method was applied.

**Table 1.** Accessions of Triticum durum lines in the study

| Nr | Accession number | Taxon name | Donor number | Durum number | Origin |
|---|---|---|---|---|---|
| 1 | AGB0171 | Triticum durum | IKB7133 | D 13 | Albania |
| 2 | AGB0172 | Triticum durum | IKB7134 | D 14 | Albania |
| 3 | AGB0175 | Triticum durum | IKB7137 | D 16 | Albania |
| 4 | AGB0176 | Triticum durum | IKB7138 | D 17 | Albania |
| 5 | AGB0178 | Triticum durum | IKB7140 | D 19 | Albania |
| 6 | AGB0181 | Triticum durum | IKB7143 | D 20 | Albania |
| 7 | AGB0183 | Triticum durum | IKB7145 | D 22 | Albania |
| 8 | AGB0185 | Triticum durum | IKB7147 | D 24 | Albania |
| 9 | AGB0190 | Triticum durum | IKB7152 | D 29 | Albania |
| 10 | AGB0196 | Triticum durum | IKB7158 | D 34 | Albania |
| 11 | AGB0214 | Triticum durum | IKB7176 | D 45 | Albania |
| 12 | AGB0428 | Triticum durum | IKB7556 | D 55 | Albania |
| 13 | AGB0429 | Triticum durum | IKB7557 | D 56 | Albania |
| 14 | AGB0430 | Triticum durum | IKB7558 | D 57 | Albania |
| 15 | AGB0433 | Triticum durum | IKB7561 | D 60 | Albania |
| 16 | AGB0435 | Triticum durum | IKB7563 | D 62 | Albania |
| 17 | AGB0438 | Triticum durum | IKB7566 | D 65 | Albania |
| 18 | AGB0442 | Triticum durum | IKB7570 | D 69 | Albania |
| 19 | AGB0443 | Triticum durum | IKB7571 | D 70 | Albania |
| 20 | AGB0444 | Triticum durum | IKB7572 | D 71 | Albania |
| 21 | AGB0446 | Triticum durum | IKB7574 | D 73 | Albania |
| 22 | AGB0453 | Triticum durum | IKB7581 | D 80 | Albania |
| 23 | AGB0454 | Triticum durum | IKB7582 | D 81 | Albania |
| 24 | AGB0455 | Triticum durum | IKB7583 | D 82 | Albania |
| 25 | AGB0459 | Triticum durum | IKB7587 | D 86 | Albania |
| 26 | AGB0461 | Triticum durum | IKB7589 | D 88 | Albania |
| 27 | AGB0466 | Triticum durum | IKB7594 | D 93 | Albania |
| 28 | AGB0469 | Triticum durum | IKB7597 | D 95 | Albania |
| 29 | AGB0474 | Triticum durum | IKB7602 | D 99 | Albania |
| 30 | AGB0475 | Triticum durum | IKB7603 | D 100 | Albania |
| 31 | HELIDUR | Triticum durum | BOKU | HELIDUR | Albania |
| 32 | DBC-480-1 | Triticum durum | BOKU | DBC-480-1 | Albania |
| 33 | REMUS | Triticum durum | BOKU | REMUS | Albania |

*Agronmy caracteristic:* The experiment was implemented on the experimental fields of the Agricultural University of Tirana in Valias, from 2016 to 2017, 3.4 km from the University. The field experiment was set up in a randomized complete block design with three replications. The lines were

sown in the field in November 13, 2016. Each line was sown in three rows; row length 60 cm, row by row 20cm, variant by variant 40cm. The climate is Mediterranean. (latitude: 402405N; longitude: 0194108E; the altitude is 40 m); the average amount of rainfall was 68,22 mm and the average temperatures was 15,6°C. The yearly participation around 985 mm. The soil type is a fluvisol.

**Table 2.** List of wheat lines. (*T.durum*) in 3 replications according to the randomized block

| | **Rep 1** | | **Rep 2** | | **Rep 3** | **Randomized number** |
|---|---|---|---|---|---|---|
| D 86 | IKB7587 | D 29 | IKB7152 | D 13 | IKB7133 | 0.024294 |
| D 80 | IKB7581 | D 71 | IKB7572 | D 62 | IKB7563 | 0.926137 |
| D 22 | IKB7145 | D 57 | IKB7558 | D 34 | IKB7158 | 0.849275 |
| D 71 | IKB7572 | D 100 | IKB7603 | REMUS | REMUS | 0.370501 |
| D 100 | IKB7603 | D 60 | IKB7561 | D 80 | IKB7581 | 0.447216 |
| D 57 | IKB7558 | D 22 | IKB7145 | DBC-480-1 | DBC-480-1 | 0.242375 |
| D 14 | IKB7134 | D 17 | IKB7138 | D 20 | IKB7143 | 0.048119 |
| D 34 | IKB7158 | D 16 | IKB7137 | D 57 | IKB7558 | 0.822781 |
| D 20 | IKB7143 | D 45 | IKB7176 | D 71 | IKB7572 | 0.94408 |
| D 55 | IKB7556 | D 20 | IKB7143 | D 45 | IKB7176 | 0.03564 |
| | DBC-480-1 | D 80 | IKB7581 | HELIDUR | HELIDUR | 0.692398 |
| D 62 | IKB7563 | D 56 | IKB7557 | D 14 | IKB7134 | 0.187986 |
| D 29 | IKB7152 | D 99 | IKB7602 | D 17 | IKB7138 | 0.645663 |
| D 95 | IKB7597 | D 93 | IKB7594 | D 65 | IKB7566 | 0.219029 |
| D 13 | IKB7133 | D 65 | IKB7566 | D 16 | IKB7137 | 0.741393 |
| | HELIDUR | D 55 | IKB7556 | D 56 | IKB7557 | 0.251089 |
| D 99 | IKB7602 | HELIDUR | HELIDUR | D 93 | IKB7594 | 0.144335 |
| D 24 | IKB7147 | D 34 | IKB7158 | D 86 | IKB7587 | 0.756955 |
| D 19 | IKB7140 | D 13 | IKB7133 | D 60 | IKB7561 | 0.20111 |
| D 69 | IKB7570 | D 86 | IKB7587 | D 81 | IKB7582 | 0.941203 |
| D 16 | IKB7137 | DBC-480-1 | DBC-480-1 | D 29 | IKB7152 | 0.831462 |
| D 70 | IKB7571 | D 70 | IKB7571 | D 73 | IKB7574 | 0.042644 |
| D 56 | IKB7557 | D 81 | IKB7582 | D 55 | IKB7556 | 0.34827 |

| | | | | | | |
|---|---|---|---|---|---|---|
| D 45 | IKB7176 | D 14 | IKB7134 | D 19 | IKB7140 | 0.74788 |
| D 82 | IKB7583 | D 19 | IKB7140 | D 95 | IKB7597 | 0.996996 |
| D 17 | IKB7138 | D 95 | IKB7597 | D 24 | IKB7147 | 0.122931 |
| D 65 | IKB7566 | D 24 | IKB7147 | D 88 | IKB7589 | 0.812496 |
| D 88 | IKB7589 | D 69 | IKB7570 | D 22 | IKB7145 | 0.052918 |
| REMUS | REMUS | D 62 | IKB7563 | D 69 | IKB7570 | 0.546252 |
| D 93 | IKB7594 | REMUS | REMUS | D 70 | IKB7571 | 0.882814 |
| D 81 | IKB7582 | D 88 | IKB7589 | D 82 | IKB7583 | 0.101913 |
| D 60 | IKB7561 | D 82 | IKB7583 | D 100 | IKB7603 | 0.028155 |
| D 73 | IKB7574 | D 73 | IKB7574 | D 99 | IKB7602 | 0.266363 |

*Inoculum production*: The inoculum was first produced at the Institute of Biotechnology in Plant Production, IFA-Tulln, Austria, utilizing mung bean broth with the bubble breeding method (Lemmens *et al*. 2004). In short, 20 gr mung beans (*Vigna radiata* L.) were cooked for 20 minutes in 1 L water. Inoculum was prepared with the bubble breeding method using a liquid mung bean. Thereafter the beans were decanted and the supernatant was autoclaved. After cooling the bottles (10L) were seeded with the *F. culmorum* isolate (IFA91015). To produce macroconidia of *F. culmorum* (isolate IFA 104), a mixture of wheat and oat seeds (2:1 v/v) was filled in baby food jars (20 gr seeds/jar) and soaked overnight in water. After 24 hours the excess water was decanted and the jars were autoclaved. The jars were subsequently seeded with the Fusarium strain, incubated for 2 weeks at room temperature. Thereafter they were stored in the refrigerator. On each inoculation day the inoculum was freshly prepared. Macroconidia were washed from the kernels, and counted in a Bürker-Turk counting chamber. Final concentration of the macroconidia was set at 50.000 conidia/ml.

*Fusarium head blight resistance testing:* Spray inoculations were performed individually for each genotype at flowering (Zadoks *et al*., 1974) using a hand sprayer. In the afternoon a bunch of about 20 flowering ears were treated with 20 mL inoculum. Thereafter each bunch was covered with a plastic bag for 24 hours in order to assure a high humidity necessary to provoke fungal infections.

*Disease assessment and other parameters:* After artificial inoculation, progress of the disease was assessed by visual evaluations of the percentage (0-100%) of visually diseased spikelets in the bunches at day 10, 14, 18, 22 and 26 after anthesis. With this data the Area Under Disease Progress Curve (AUDPC) for FHB intensity was calculated for each line (Shaner and Finney 1977). Disease intensity was taken as a measure for resistance against

spreading of the disease (Type II). At the end of the season the wheat lines were harvested and the percentage of visually Fusarium damaged kernels (KE) in the harvested kernels was assessed.

In addition, plant height (PH) and anther extrusion (AE) were assessed. The latter parameter was evaluated as follows. Three days after flowering, 20 florets were at random selected for each individual wheat line and investigated for the presence of anthers. If a single or more anther(s) was present in the floret, the floret was considered to retain the anther. Anther retention was evaluated: the number of florets containing at least one anther was counted. A high number of florets containing at least one anther shows that the line has a low anther extrusion.

*Statistics Analysis*: SPSS® was used for statistical evaluation such as ANOVA (PROC GLM) and correlation analyses (PROC CORR).

## 3. RESULTS AND DISCUSSION

In Table 3 reports the mean values of the five visual disease evaluations done in the field (B1, B2, B3, B4, and B5), the AUDPC for each line, the plant height (PH), the anther extrusion (AE) and the kernel evaluation (KE). The analysis of variance was done to show if there was any significant difference between the genotypes related to the data obtained from the field experiment (Table 3).

**Table 3.** Values of the five visual disease evaluations (B1, B2, B3, B4, and B5), AUDPC, Plant Height (PH), Anther Extrusion (AE) and Kernel Evaluation (KE).

Descriptive Statistics

| | N Statistic | Range Statistic | Minimum Statistic | Maximum Statistic | Mean Statistic | Mean Std. Error | Std. Deviation Statistic | Variance Statistic |
|---|---|---|---|---|---|---|---|---|
| genotypes | 99 | 32 | 1 | 33 | 17,00 | ,962 | 9,570 | 91,592 |
| kernel evaluation | 99 | 83 | 2 | 85 | 34,33 | 2,006 | 19,960 | 398,388 |
| B1 | 99 | 25,00 | ,00 | 25,00 | 8,9394 | ,64814 | 6,44889 | 41,588 |
| B2 | 99 | 36,00 | 4,00 | 40,00 | 19,2121 | ,93284 | 9,28162 | 86,148 |
| B3 | 99 | 65,00 | 10,00 | 75,00 | 41,4646 | 1,54679 | 15,39037 | 236,864 |
| B4 | 99 | 85,00 | 10,00 | 95,00 | 59,3434 | 1,57223 | 15,64345 | 244,718 |
| B5 | 99 | 55,00 | 45,00 | 100,00 | 77,8081 | 1,30059 | 12,94074 | 167,463 |
| plant height | 99 | 62,00 | 70,00 | 132,00 | 90,3939 | 1,11841 | 11,12803 | 123,833 |
| anther extrusion | 99 | 8,00 | 12,00 | 20,00 | 18,5455 | ,18120 | 1,80290 | 3,250 |
| AUDPC | 99 | 850,00 | 255,00 | 1105,00 | 698,2727 | 16,42535 | 163,43018 | 26709,425 |
| Valid N (listwise) | 99 | | | | | | | |

Table 4 shows the difference between the 33 genotypes regarding each of the 5 parameters (B1, B2, B3, B4 and B5) individually. Regarding the first evaluation (B1) of FHB intensity the analysis of variance shows that there is no significant difference between the genotypes. Probability of the Zero Hypothesis (=there is no difference between genotypes) is 0.6364, i.e., the Zero Hypothesis can be accepted. There is a significant difference among genotypes for the parameter B2. Probability of the Zero Hypothesis (= there is no difference between genotypes) is 0.0131, which is smaller than 0,05 (=5%). Therefore, the Zero Hypothesis has to be rejected, while the Alternative Hypothesis (=there are significant differences between the Durum genotypes) has to be accepted. This is also shown by the value of LSD 0.05 (Least significant difference at the 0.05 probability level) that in case of the parameter B2 it is 13 (table 3). This means that 2 genotypes which differ in the mean B2 value more than 13 B2-Units are significantly different from each-other. No significant difference between genotypes was shown from analysis of variance related the parameter B3 and B4 (Table 4) with a Probability of 0.6461 and 0.3077, respectively. There is instead a significant difference between genotypes related to the last evaluation B5 with a Probability of 0.0412.

**Table 4.** Analysis of variance of the 33 wheat genotypes under investigation related to the five visual evaluations of the disease intensity.

B1

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1243,636 | 32 | 38,864 | ,906 | ,613 |
| Within Groups | 2832,000 | 66 | 42,909 | | |
| Total | 4075,636 | 98 | | | |

B2

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 3808,545 | 32 | 119,017 | 1,695 | ,036 |
| Within Groups | 4634,000 | 66 | 70,212 | | |
| Total | 8442,545 | 98 | | | |

B3

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 7845,960 | 32 | 245,186 | 1,053 | ,419 |
| Within Groups | 15366,667 | 66 | 232,828 | | |
| Total | 23212,626 | 98 | | | |

B4

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 8915,657 | 32 | 278,614 | 1,220 | ,244 |
| Within Groups | 15066,667 | 66 | 228,283 | | |
| Total | 23982,323 | 98 | | | |

B5

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 7496,687 | 32 | 234,271 | 1,734 | ,030 |
| Within Groups | 8914,667 | 66 | 135,071 | | |
| Total | 16411,354 | 98 | | | |

Analysis of variance was also performed to show if there are significant difference between the genotypes regarding the AUDPC, Plant Height (PH), Anther Extrusion (AE) and Kernel Evaluation as shown in Table 5. There is no significant difference between the genotypes regarding the parameters AUDPC and AE (Table 5). There is instead a highly significant difference between the 33 wheat genotypes related to plant height (PH) with a probability of 0.001 and KE with a probability of 0.03. (Table 5).

**Table 5.** Analysis of variance of the 33 wheat genotypes under investigation related to AUDPC, Plant Height (PH), Anther Extrusion (AE) and Kernel Evaluation (KE).

AUDPC

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1013384,970 | 32 | 31668,280 | 1,303 | ,181 |
| Within Groups | 1604138,667 | 66 | 24305,131 | | |
| Total | 2617523,636 | 98 | | | |

Plant height

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 8890,970 | 32 | 277,843 | 5,652 | ,000 |
| Within Groups | 3244,667 | 66 | 49,162 | | |
| Total | 12135,636 | 98 | | | |

Anther extrusion

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 85,212 | 32 | 2,663 | ,753 | ,809 |
| Within Groups | 233,333 | 66 | 3,535 | | |
| Total | 318,545 | 98 | | | |

Kernel evaluation

KE

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 17694,667 | 32 | 552,958 | 1,710 | ,033 |
| Within Groups | 21347,333 | 66 | 323,444 | | |
| Total | 39042,000 | 98 | | | |

Table 6 reports the three commercial Austrian durum lines (DBC4801, Remus and Helidur) and two durum lines from the Albanian Gene Bank: the most susceptible one IKB7602 and the most resistant one IKB7581. The graphics in Figure 1 plot the comparison of the FHB spreading in these lines (Figure 1). IKB7602 looks very promising in this comparison. In fact, it shows pretty nice resistance, almost as good as the two Austrian lines, REMUS and DBC4801 that are known to show good resistance against FHB

(Figure 1). HELIDUR is instead a susceptible one and IKB7581 it is very susceptible against FHB spreading. Indeed, the most susceptible as shown in Figure 1.

**Table 6.** The five visual evaluation of FHB spreading of the three Austrian wheat lines (DBC4801, Remus and Helidur) and two Albanian wheat lines from the Gene Bank (IKB7602 and IKB7581), the most and the less susceptible one.

| Name | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|
| **DBC4801** | 7 | 10 | 17 | 47 | 65 |
| **IKB7602** | 2 | 7 | 32 | 38 | 77 |
| **REMUS** | 13 | 28 | 33 | 40 | 55 |
| **HELIDUR** | 12 | 20 | 33 | 55 | 68 |
| **IKB7581** | 7 | 23 | 52 | 83 | 95 |

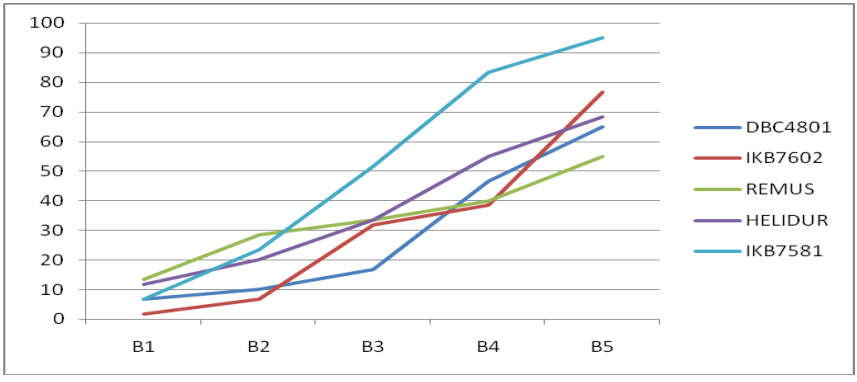


**Fig.1:** Comparison of the FHB symptoms between the three commercial Austrian durum lines and the two Albanian durum lines.

Correlation analysis showed the best correlation between AUDPC-B3, AUDPC-B4 and AUDPC-B5, meaning that the disease intensity gets higher after two weeks from infection. AUDPC and plant height have a week correlation with a negative value -0.33. This means that plant height might play a role in slowing down the disease from spreading. A very week positive correlation, only 0.18, is shown instead by the AUDPC and the anther extrusion (Table 7). We expected to have a negative correlation between these two parameters (AUDPC and AE) knowing that anther retention is known to slow the spreading of the disease in the case of Fusarium infection. Although the correlation is positive, it is very week and this might mean that other factors can be the cause.

**Table. 7** Correlation analysis between the data obtain from the visual evaluation of the disease, AUDPC, PH, AE ad KE of the 33 durum lines**.**

| Pearson correlation | | Kernel evaluation | B1 | B2 | B3 | B4 | B5 | Plant height | Anther extrusion |
|---|---|---|---|---|---|---|---|---|---|
| kernel evaluation | Pearson Correlation | 1 | -0,136 | -,204* | -,217* | -,230* | -,292** | ,253* | 0,079 |
| | Sig. (2-tailed) | | 0,181 | 0,043 | 0,031 | 0,022 | 0,003 | 0,012 | 0,436 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| B1 | Pearson Correlation | -0,136 | 1 | ,469** | ,226* | 0,179 | ,257* | -0,022 | 0,067 |
| | Sig. (2-tailed) | 0,181 | | 0,000 | 0,024 | 0,077 | 0,010 | 0,831 | 0,510 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| B2 | Pearson Correlation | -,204* | ,469** | 1 | ,282** | ,279** | ,201* | -0,116 | -0,050 |
| | Sig. (2-tailed) | 0,043 | 0,000 | | 0,005 | 0,005 | 0,046 | 0,253 | 0,625 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| B3 | Pearson Correlation | -,217* | ,226* | ,282** | 1 | ,574** | ,462** | -,338** | 0,122 |
| | Sig. (2-tailed) | 0,031 | 0,024 | 0,005 | | 0,000 | 0,000 | 0,001 | 0,230 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| B4 | Pearson Correlation | -,230* | 0,179 | ,279** | ,574** | 1 | ,498** | -,325** | ,281** |
| | Sig. (2-tailed) | 0,022 | 0,077 | 0,005 | 0,000 | | 0,000 | 0,001 | 0,005 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| B5 | Pearson Correlation | -,292** | ,257* | ,201* | ,462** | ,498** | 1 | -,298** | 0,098 |
| | Sig. (2-tailed) | 0,003 | 0,010 | 0,046 | 0,000 | 0,000 | | 0,003 | 0,336 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| plant height | Pearson Correlation | ,253* | -0,022 | -0,116 | -,338** | -,325** | -,298** | 1 | -0,099 |
| | Sig. (2-tailed) | 0,012 | 0,831 | 0,253 | 0,001 | 0,001 | 0,003 | | 0,328 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| anther extrusion | Pearson Correlation | 0,079 | 0,067 | -0,050 | 0,122 | ,281** | 0,098 | -0,099 | 1 |
| | Sig. (2-tailed) | 0,436 | 0,510 | 0,625 | 0,230 | 0,005 | 0,336 | 0,328 | |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| AUDPC | Pearson Correlation | -,300** | ,577** | ,602** | **,796**** | **,791**** | **,640**** | -,331** | 0,176 |
| | Sig. (2-tailed) | 0,003 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,001 | 0,082 |
| | N | 99 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |

The screening and the assessment of the resistance of the existing wheat material are important for the improvement of FHB resistance. Finding resistant genotypes will help the breeding lines that have already been selected for their good resistance towards Fusarium to improve more in terms of FHB resistance. Consequently, 30 durum wheat lines from the Albanian Gene Bank were studied for the Type II resistance against Fusarium. Statistical analysis showed that only two out of five visual evaluations, B2

and B5, gave significant results. Three of them showed no significant differences between genotypes, which might be due to weather conditions especially dry and hot conditions during the third and fourth (B3 and B4) evaluation. These conditions are not favorable for Fusarium infection. Fisher's Least Significant Difference (LSD) Post Hoc analysis performed on the genotypes regarding B1 showed significant differences between the groups ($p \leq 0.05$) especially: IKB7140, IKB7587, IKB7574 and IKB7583. Post Hoc analysis for the B5 parameter showed significant differences ($p \leq 0.05$) between groups especially for: IKB7140, IKB7145 and IKB7138.

A significant difference between genotypes was seen from the results given by statistical analysis for plant height that led to expectations in finding resistant lines showed also by correlation analysis although very week with an r= -0.33 The negative value means that as we expected the height of the plant might restrain the spreading of the disease (Buerstmayr *et al*., 2012), expressed by the AUDPC. Anyway the correlation remains weak. The LSD Post Hoc analysis showed significant differences between the groups: DBC4801 with a Mean height of 131 cm, which was significantly higher than all the other lines. IKB7158 (90cm) was significantly different from IKB7140 (96cm) ($p \leq 0.01$) which is also significantly different ($p \leq 0.01$) from IKB7581 (87cm). Steiner *et al*., (2019) said that in addition to plant height, anther is another characteristic that might help in the resistance against spreading. The anther retention it is known to help Fusarium to infect plants as it serves as food source for the pathogen (Dickson *et. al*., 1921). In the present investigation, a very weak linear correlation between anther extrusion and AUDPC was found. Thus, these two parameters might correlate but not in a linear way. Last but not least, the correlation analysis between the spreading of the disease in the field represented from the AUDPC data and the evaluation of the diseased kernels represented from the kernel evaluation data had an r = -0.3 meaning that the field infection doesn't play much role in the disease symptoms in the harvested seeds. The diseased kernels showed significant differences between the groups in the LSD Post Hoc test: DBC4801 was significantly different from IKB7589 ($p \leq 0.035$), IKB7602-IKB7581 ($p \leq 0.02$), IKB7147- IKB7561 ($p \leq 0.003$), IKB7582- IKB7589 ($p \leq 0.02$).

## 4. CONCLUSIONS

Valuable information about durum wheat AGB collection is here reported. The diseased kernels have significant differences between the groups in the LSD Post Hoc test: DBC4801 was significantly different from IKB7589 ($p \leq 0.035$), IKB7602-IKB7581 ($p \leq 0.02$), IKB7147- IKB7561 ($p \leq 0.003$), IKB7582- IKB7589 ($p \leq 0.02$).

The present investigation is an introduction to more resistant materials. It is also important to have older wheat genotypes in gene collections because they can often be used as sources of resistance to diseases. Further examinations of selected genotypes should check differences in DON accumulation in the grains among genotypes.

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