EUROPEAN ACADEMIC RESEARCH
Vol. V, Issue 2/ May 2017

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Fusarium head blight and agronomic performance of some soft wheat cultivars in Albania

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Abstract:

Fusarium head blight (FHB) or scab, caused by Fusarium spp, is an economically devastating disease of wheat and other small grain cereal crops and it is particularly favored by conditions of high humidity and warm temperatures. In our study climatic conditions prior to wheat harvest in the year 2014-2015 were favorable for the development of field molds because of high precipitation during the heading or anthesis. (Zadoks Scale). The objectives in this study were: (i) to investigate the natural occurrence of FHB on nine winter wheat cultivars grown during the year 2014-2015 on experimental fields of Agriculture Technology Transfer Center (ATTC) Lushnja; (ii) to understand the correlation between different degrees of infestation and both yield and thousand kernels weight correspondents . Values of FHB index quantified as percent diseased spike, YLD (kv/ ha) and TKW were recorded. The disease index average was 15.72%, varying in range 4.83 % to 34.93 % in the untreated cultivars. The experiment was set under conditions of natural infection and a protective fungicidal treatment during heading and anthesis on the same

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cultivars. The statistical evaluation indicated that exists a strong correlation between relative yield reduction (%) and DI (disease index) (r = 0.9) and a medium correlation between relative TKW reduction (%) and DI (r= 0.7).

Key words: *Fusarium Head blight*, wheat, disease index, TWK, yield.

INTRODUCTION

Wheat is the most important staple food for more than one third of the world population and contributes more calories and proteins than any other cereal crops (Shewry 2009). It is considered a good source of protein, minerals, B-group vitamins and dietary fiber although the environmental conditions can affect nutritional composition of wheat grains with its essential coating of bran, vitamins and minerals (Simmonds 1989). In Albania the total area planted with grain is 69.600 hectares, almost a quarter of the area planted before 1990. The total wheat production for 2015 was 275.000 tones (Source of information: Ministry of Agriculture, Rural Development and Water Administration). FHB is one of the most economically important diseases of wheat and causes yield losses, grain quality reduction and contamination on grain with mycotoxins (Gotswami and Kisler 2004). *Fusarium* infection has been a problem recently due a change in climate condition. Epidemics occur when most and warm weather conditions coincide with flowering stage. (C. Jansen et al).Infection from the fungus during anthesis of wheat can afflict starch qualities and it results in a higher degree of damaged starch gluten proteins and albumin (Scala et al 2016) . During the anthesis, the anthers naturally split to release pollen which provides an opening for the pathogen to enter to the wheat plant (Brown et al 2010). This can result in a decrease of thousand kernel weight because of starch consumption from the fungus (Boyacioğlu et al 1995).Yield loss results when primary

infection of spikelet's by ascospores of *G. zeae* is followed by rachis colonization and death (Sutton et al 1982). Susceptible cultivars have greater indices of spread in the rachis (Ginkel et al 1996). In highly susceptible cultivars, 50 to 80% of developing spikelets may be killed or damaged prior to grain fill (Schroeder et al 1955). Additional loss results during mechanical harvest because shrunken and light-weight seed produced in affected heads are not retained by combine fans and sieves (Pomeranz et al 1990). Infected spikelet's yield seed with characteristic visual symptoms have a pink, chalky white or pale gray color and a "tombstone" appearance. (Lear and Patrick1990, Tkachuk et al 1991) .Tombstone kernels have low densities and are reduced in size (Wiersma et al 1996). The cultivar genotype and environmental factors influence the growth, survival, dissemination, the incidence *of Fusarium* fungi and the disease severity (Koch et al. 2006, Klem et al. 2007) in different crop management practices. In our experiment we have plant cultivars with different susceptibility against Fusarium infection. Lushnja region was chosen because conditions that favor the development of the disease usually coincide with conditions that favor crop growth in this area (spring is relatively warm and humid in this region) (Hasani et al 2002, 10) .

The purpose of this study were: (i) to investigate the natural occurrence of FHB on nine winter wheat cultivars grown during the year 2014-2015 on experimental fields of Agriculture Technology Transfer Center (ATTC) Lushnja and understanding the correlation between different degrees of infestation andboth yield and thousand kernels weight in those cultivars.

MATERIAL AND METHODS

Locations and experimental design:

The effect of different infection grades of *Fusarium spp* was evaluated for nine winter wheat cultivars samples planted during the years 2014-2015 on experimental fields of the State of Seed and Saplings (ATTC) in Lushnje (40°57′06″N, 19°41′08″E). The plant material was naturally contaminated during growth in the field. Two protective fungicidal treatment with tebuconazol were performed during heading and anthesis in order to have undamaged cultivars from fusariosis effect in one replication. Field trials were carried out by methods of randomized blocks in four replications; the size of each plot was 10 square meters. For visual estimation for each plot, 10 heads were taken, at five places of, its diagonals, resulting in a total of 50 heads per plot. Agro-technical practices have been the same based on type protocol established previously for the distance of planting, seed rate, doses of fertilizers, hoeing, etc.

PLANT MATERIAL

Nine soft wheat cultivars; Dajti, Lucia , Katerina, Mateo, Apache, Simonid, Azul, Bizancia and Krajlica taken into investigation were cultivated in the same location at experimental fields of the State of Seed and Saplings (ATTC) Lushnja .

DISEASE ASSESSMENTS

Times Assessments: Assessment of *Fusarim spp* was made two times each Zadoks growth stage GS 60 and GS 75. (Zadoks et al 1974) Two measures were obtained per spike disease assessment: incidence (presence or absence of disease anywhere on the plant) and severity (percentage of each spike with disease symptoms).

Visual Estimation: Visual estimation of disease severity from natural infection *Fusarium* Head Blight (caused by *Fusarium spp*) was used. Assessment of *Fusarium* infections has been based on standard area diagrams (SADs) the percent of covered leaves surface occupied by the disease. (Images for SAD s created using Severity Pro software10. (See Figure 1)

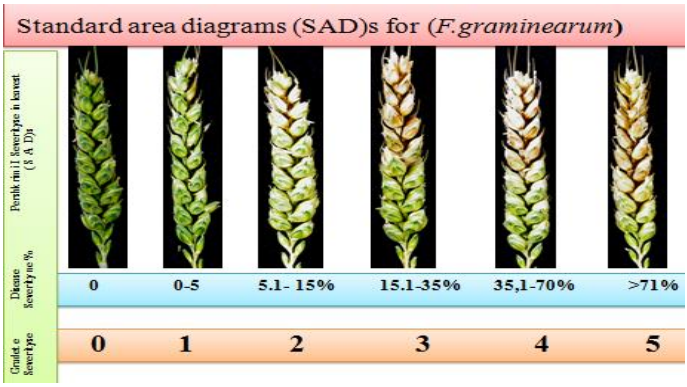

Figure 1. Standard area diagrams used to estimate FHB (*Fusarium spp*)

Severity and diffusion of infection were obtained by resorting to the McKinney index (H.H.McKinney 1923) and modified from Cooke. (Cooke 2006). The McKinney index (Imc %) was obtained by using the following formula $Imc = \Sigma \{(ni \cdot xi) / N \cdot X\} \cdot 100$

Where: ni = infection class frequencies; xi = number of plants of each class; N = total of observed plants; X = highest value of the evaluation scale

Yield analysis: Total yield was assumed to be related to the components of yield (number of tillers, number of kernels per head, and 500 kernel weight) by the following relationship:

$$Y=t*k*w*c$$

in which y = grain yield in kilograms per hectare, t = number of tillers per meter row, k=number of kernels per head where number of heads is assumed to equal number of tillers in a

given area, w =weight of 500 kernels, c= a constant that includes correction for differences in units.

Thousand kernel weight test

Wheat moisture contented and kernel weight were determined by the methods described by Dexter and Tipples 1997.

Statistical Date Analysis: All **s**tatistical analyses were performed using Minitab 17 and Excel 2007.

RESULTS AND DISCUSSIONS

Weather data for 2015 for April, May and June are presented in Table 1. During the late-vegetative and grain-filling period, the air temperatures were about 24 ºC and rainfalls were intensive in April and May. Wheat harvest was delayed at some locations due to heavy rainfall at the time of desired harvest.

Table -1 Weather condition for Lushnja region 2015

Year	Location	Variables		April	May	June
2015	Lushnja	T in (C)	mean	14	18.1	22.6
			Min	7.7	12.6	17.1
			Max	20.8	24,1	28.8
		Rain falls (mm)		58	64	12
		Humidity		78	68	65

Table- 2 shows data for evaluated parameters; disease index (Imc) in% , thousand kernel weight (TKW) in grams for natural infected (NI) yield in t/ha for natural infected (NI) , yield for treated cultivars (T) and TKW for the treated cultivars.(T **)**

Differences between the treatments with tebuconazole and natural infection were visible for all traits. Thousand kernel of wheat TKW (NI) ranged from 36.9g (Dajti) to 48g (Lucia) and in treated cultivars this value was 52,3 gram for genotype Lucia and 44 gram for genotype Dajti.

The highest reduction of TKW was for genotype Simonid (9.2 g) were disease index was 29.92%. According to Dexter et al 1996, kernel weights were strongly inversely related to damage kernels because of the shriveled nature of *Fusarium* damaged kernels.

Table - 2 The data for Imc, TKW and Yield

Nr.	***Cultivar***	***TKW (NI)(g)***	**yield (NI) (t/ha)**	**Imc %**	**yield T (t/ha)**	**TKW (T) (g)**
1.	Lucia	48	4.8	4.83	5.1	52.3
2.	Katerina	38	4.2	16.19	5.59	45
3.	Mateo	43.5	5.4	9.29	6.33	51.3
4.	Apache	40	4.84	21.11	6.82	44
5.	Simonid	38.4	4.10	29.93	6.88	47.6
6.	Asul	44	5.23	5.21	5.63	48.8
7.	Bizancia	43	4.66	15	5.35	49.4
8.	Krajlica	46	5.9	5	6.05	49.8
9.	Dajti	36.9	3.5	34.93	5.5	44

This reduction may be as a result of consumption of starch and storage proteins form the fungus. Boyacioğlu D and Hettiarachchy reported that Fusarium destroys starch granules because of the production of amylase and protease. Infected spikelet's yield seed with characteristic visual symptoms have a pink, chalky white, or pale gray color and a" tombstone" appearance (Tkachuk 1991).In highly susceptible cultivars, 50 to 80% of developing spikelet's may be killed or damaged prior to grain fill (Schroeder 1962).

We didn't found any correlation between the reduction of TKW in grams and disease index but we had found a medium correlation between relative reduction of TKW in % [TKW (T) – TKW (NI) /TKW (T) *100] and disease index. Using linear regression analysis a medium correlation ($R^2 = 0.496$) between the relative reduction of TKW (Rel R TKW) and the disease index was determined Fig 2. This result is in accordance with different studies (Wiersma 1996. Fig 1 describes the graphic of regression between relative reduction of TKW % (Rel R TKW) and disease index (Imc).

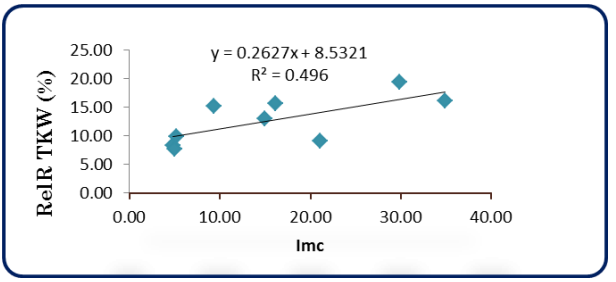

Figure 2. The linear regression between relative TKW reduction (%) and disease index (Imc)

Yield in the natural infected cultivars ranged between 3.5 t/ha for Dajti which has also the greatest value for disease index (34.92%) and Krajlica with a value of 5.9 t/ha (Imc 5%).

In our study we found distinctive differences between the two variants (natural and fungicide treatment) for yield in kv/ha. The highest reduction of yield was for genotype Simonid 2.77 t/ha with 29.92% disease index. Similar results are in accordance with other study (Tkachuk, R., Dexter, J.) that indicate a dramatic decrease of yield due to *Fusarium* head blight infection. A significant positive linear correlation between relative reduction of yield and disease (r =0.953) was observed. To calculate the yield reduction in % was used the following formula : [Yield (T) – Yield(NI) /Yield (T) *100] In a recent study highly susceptible cultivars, 50 to 80% of developing spikelet's may be killed or damaged prior to grain fill (Lear et al 1990) . Additional loss results happen during mechanical harvest because shrunken and light-weight seed produced in affected heads are not retained by combine fans and sieves (Pomeranz et al 1990). These results are completely in accordance with our study. We think that this strong relation was a result of infection from the fungus during anthesis because of high and humid climate during May in Lushnja region. Fig 2 is described the linear analysis between relative Yield reduction and disease index (Imc).

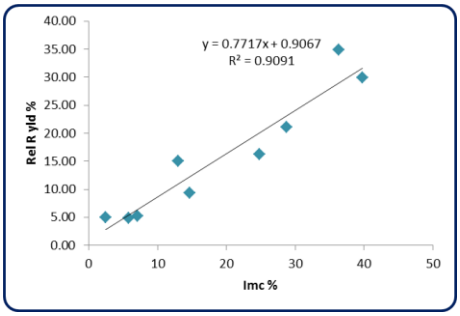

Figure 3. The linear regression between relative yield reduction (%) and disease index (Imc)

The analyzes of hierarchic classification (HFC) in order to obtain the dendogram of similarity (Fig 4) was performed using the methods of Euclidian distance for the variables Imc (%), Rel R yld (%), Rel R TKW (%). By incision of the dendogram, the nine cultivars of soft wheat were categorized in there clusters. The cultivars 1,6,8,3 and 7 were classified in the first cluster with a mean Euclidian distance 5 (max 7.5). In the second cluster are included Katerina and Apache with a Euclidian distance 3.8, meanwhile in the third cluster are grouped cultivars Simonid and Dajti with a Euclidian distance 2.4. We can detect that same classes are determinate from behavior of the same cultivars towards disease index (Imc).

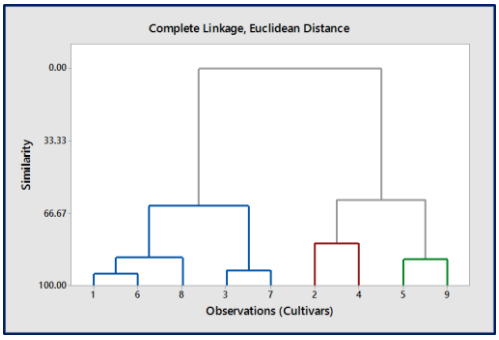

Figure 4. The dendrogram created by HFC for data of Imc(%), Rel R yld (%), Rel R TKW (%) for studied cultivars .

CONCLUSION:

According to our study, the wheat cultivars Lucia, Asul and Krajlica with mean value 5% of disease index have shown higher level of resistance against Fusarium Head Blight even though they were grown in the same location with same climatic conditions. It is observed great differences between a thousand kernel weight, yield for all the samples in natural infected and treated cultivars we had not found a correlation between reduction of TKW and disease index, as well between reduction of yield and disease index. There is a strong positive correlation (r=0.953 and p=0.05) between relative yield reduction % (Rel R yld) and disease index and a medium positive correlation (r=0.704 and p=0.05) between relative reduction of TKW in % and disease index (Imc %).

According to the data obtained from the analyses of hierarchic classification (HFC) cultivars with disease index 5-15% represent high level of similarity.

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