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The Study of the Relationship Between Traits and Resistance to Fusarium Head Blight (FHB) in Spring Wheat Genotypes

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Abstract: FHB is one of the most worldwide important diseases which both reduces the function and the quality of the seeds and infects them to fungous toxins. Various methods to control crop disease contain chemical control, agronomic control and amend to create resistant varieties. Amend to create resistant varieties are known as the best method to control the disease. Better understanding the relationship between plant morphological traits and resistance to FHB can be effective in a successful implementing a reform program. In this experiment the relationship between the disease indicators with each other and morphological traits such as the plant height, peduncle length and density of spikelet on the spikes was accomplished. A significant and negative correlation was observed between plant height and peduncle length and susceptibility to FHB. The existence of long-legged in wheat crop is considered as an undesirable agronomic trait, so the correlation between these traits with resistance to FHB is not suitable for reformers. In this study by drawing two-dimensional diagram of the sensitivity of spikelet on the spike, the selection of high density genotypes and good resistance to FHB was started out. Considering the high density of spikelet can be a positive trait in an operation. In this study by drawing two-dimensional diagram of sensitivity component against the density of spikelet on the spike was accomplished to high density genotypes and proper resistance to FHB.

Key words: FHB · Morphological traits · Resistance · Two-dimensional Diagram and Wheat

INTRODUCTION

Fusarium head blight (FHB) is one of the most important diseases in the world. About 17 species of FHB are known as the cause of this disease, *Fusurium graminearum* and Fusurium *cubnorum* are the main elements of it [1]. Years ago, the spread of the disease exists in Iran and it is considered as one of the major diseases of wheat in the province of Mazandaran, Golestan, Zanjan, Ardabil (Moghan plain) and Fars in Iran [2]. FHB of wheat has been reported in many countries such as Russia, France, Sweden, Italy, Germany, Australia, Brazil, Norway, Japan and Canada. In most reports *Fusurium graminearum* has been introduced as the main cause of the disease [3]. The disease damages to the wheat crop have different dimensions. Operation results loss by reducing the number and weight of seeds. This report has been reduced from 30 to 70 percent. FHB by damaging starch and protein reserves and damage to the cell wall reduces grain quality in bakery product [2]. The disease by damaging the embryo causes the reduction of seed vigor and produces wheat seedling blight in the next product. The fungal toxin contamination of seeds of Newelenol, Zearalenol and Dioxinewelenol is considered as a serious danger for mankind and animal. In order to control FHB variety of methods, including methods of agronomic and chemical control and ultimately improved crop resistant varieties has been presented. Agronomic control methods include crop rotation and use of appropriate, accurate methods of irrigation, fertilizer use and proper field preparation [3]. The correction for the creation of resistant varieties is the most effective way to control this disease. Using this method agrees well with the environment and it covers the reduction of the damage caused by yield loss, quality loss and fungal toxin accumulation in grain simultaneously [4]. Toth *et al*. [1] has announced five different mechanisms as a mechanism of active resistance against FHB. These mechanisms include the type of resistance with resistance to initial infection, second type of resistance or resistance to the spread of infection within the spike, The third type of resistance to infection or infected seeds in the spikelet,

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the fourth type of resistance or reduced to reduction of yield and the fifth type tolerance or tolerance to the accumulation of contaminated grain. Passive resistance and includes mechanical resistance and escape mechanism includes morphological traits such as plant height, awn exist, spikelet's on the spike density, flowering time and its durability, the wax coating of spikelet and the volume of openness of spikelet [5]. Better understand the relationship between plant morphological traits can be effective in Successful breeding program [5]. Ma *et al*. [7] with markers (RFLP) started out to investigate FHB in barley plants by using the connected indicators to shrub traits, peduncle length and density of spikelets on the spikes with resistance to quantitative traits loci (QTL) blight. In the other study Choo *et al*. [6] examined the relationship between morphological traits in barley with resistance to FHB related to short-legged genotypes with sensitivity to QTL blight.

The aim of this research was to realize relationship between traits and resistance to Fusarium head blight in spring wheat genotypes.

MATERIALS AND METHODS

Thirty spring wheat genotypes were evaluated with three replicates in a randomized complete block design in agricultural research station in the Iraqi city of Gorgan (Iran), the two test stress disorder (pollution of artificial insemination with liquid mushrooms *F.gramineanm*) and other test stress condition (disease control using fungicide tilt). Cultivation of each genotype on two meter rows with plants 30 cm width 60 cm, in two lines and Mono was done manually. Thus, 30 genotypes of spring wheat, including twenty-eight genotypes of bread wheat (*Triticum aestivum*) and two varieties of durum wheat (*Triticum durum*) Stork and Yavars were evaluated.

Fungal Spore Suspension: In order to prepare a spore suspension of fungi one isolate of *F. gramineanm* were prepared from plant and seed breeding center in Karaj, Karaj Iran. In order to prove pathogenicity, the contamination by the micropipette in the middle spikelet per spike was in the anthers. The proof of pathogenicity, the isolates of potato dextrose agar medium (PDA) was cultivated. Fungal suspension for the 2.5 g of powdered wheat straw and 2.5 g of powdered barley straw in 250-ml Erlenmeyer flask and poured into 125 ml of water was added. Flasks twice with an interval of 24 hours in an autoclave for 30 min with a temperature of 120°C and atmospheric pressure were sterile. Pieces and each piece cut a square centimeter of the PDA environment; the above was added into the flasks. Flasks in the incubator shaker incubator at 25°C and 120 rpm were used. After 96 hours of coverage under the hood open flasks using a sterile fluid Tiffany flasks were flat. Concentration using Makrokindy calculated by adding water to the slide Hemocytometer Makrokindy 100 000 /ml was given.

Infecting Genotypes: Pollution was performed by spur spraying on spikelet in the early flowering stage when the anthers of the middle ear begin to come down, the stage 60 zadox [8]. Spur spraying was performed on the whole genotypes four times in two days.

Calculation of Disease Indices: Before appearance of infection symptoms 30 wheatears were randomly selected and labeled. The symptoms of pollution in the genotype, the number of infected spikelet per spike was counted with the label. To calculate the disease incidence as a type of resistance, the following equation was used [9]:

$$\text{Disease incidence} = (\text{number of spike with infected spikelet})/30$$

Percent disease occurrence equal to 30 divided by the number of infected spikelet's per spike containing For the second type of resistance as an indicator of disease severity, assessed by the percentage spikes infected spikelet's per spike was graded as follows:

0 = All spikelets in a spike has no symptoms.
1 = Up to 20 percent of infected spikelets per spike.
2 = Up to 40 percent of infected spikelets per spike.
3 = Up to 60 percent of infected spikelets per spike.
4 = Up to 80 percent of infected spikelets per spike.
5 = More than 80 percent of infected spikelets per spike.

And then using the following relationship, severity of disease was calculated [10].

Disease severity =
[(the number of spikes with level 1×1) + (the number of spikes with level 2×2) +…+ (the number of spikes with level 5×5)] / (infected spikes×5

At the plant maturity time, harvesting was done by hand. And 15 spikes from labeled spikes were chosen randomly and the head of spikes was placed into the paper envelopes in order to avoid the loss of grains.

Infected grain (%) = Number of infected seeds / Total number of seeds

After ripening, each genotype was picked by hand separately in two environmental disease stress and witness and crushed by combine testing then the seeds separated and weighed. In this method the win combine was set to avoid removing as possible from reduction of SSI lightweight and rotten seeds. Seeds of each plot were weighted and by using the flowing equation, SSI index (Stress susceptibility index) was calculated as an indicator of performance [11].

$$SSI = [1- (Ys)/(Yp)]/SI:$$
$$SI=1- (\acute{Y}s/\acute{Y}p)$$

Yp : Yield of genotype in free stress condition
Ys : Yield of genotype in stressful condition
SI : Stress severity

The weight of 1000 seeds, the number of each plot and the number of seeds in spike calculated and analyzed by use of compound analysis. The calculation of coefficients of correlation was using the procedure Corr and analysis of variance using the procedure Glm and the principal components using the procedure Princomp in the statistical software SAS, calculation of its values in the software excel and drawing of two-dimensional diagrams was done by using SPSS.

RESULT AND DISCUSSION

Given the significant difference between genotypes in terms of disease indicators, Duncan's multiple range test based on genotypes were grouped in the one percent level (Table 2). In order to achieve to an overall index for the sensitivity of genotype on farm, principal component analysis using indicators of disease occurrence (DIC) disease severity (DSV) the infected percentage (FDK) and yield index (SSI) was done respectively as the first, second, third and fourth disease resistance indicators. The first component justifies about 79 percent of sensitivity changes to FHB is shown as the following and was named as the sensitivity it FHB.

$$ZI = (0.53\times DIC) + (0.47\times DSV) + (0.51\times FDK) + (0.48\times SSI)$$

Morphological Traits: Analysis of variance in the frame of randomly blocks for this trait showed significant differences between the numbers on the spike from the view point of plant height, peduncle length and spikelets density (Table 3). A significant negative correlation between the level of a percent disease indices and plant height were found (Table 4). Forontana as the most long-legged figure among Geneva's average assessed in terms of component sensitivity were between genotypes resistant. The number of Forontana resistant varieties and Engoshby and MX Forontana with more than one hundred given that one of the tree parents of Forontana

Table 1: Grouping of genotypes based on indicators of resistance, with duncan multi range test.

Genotype	Occurrence of disease (%)	Disease severity (%)	Infected seeds (%)	Genotype	Occurrence of disease (%)	Disease severity (%)	Infected seeds (%)
Arta	43.22g	32.06cde	10.87cd	Ning8343	9.33klm	20gh	0.25k
Atila/Milan	41.78g	21.78fgh	7.12g	Ningmai8026	33.33h	25.08efgh	3.77hi
Atrak	92.22a	29.32defg	16.22b	Sha3/cbrd	12.22kl	20.83gh	1.62jk
Atrak/wangellabi	45.56fg	27.34def	2.77ij	Sha4/chill	28.89hi	27.33defg	3.59hi
Carbrid	6.67klm	20gh	0.63k	Shanghai8	4.34lm	20gh	0.17k
Chamran	66.11cd	44.86b	7.88fg	Shanghai3	4.42lm	30.67cdef	0.62k
desconcido	58.86de	34.65cd	9.62def	shiroodi	52.22ef	39bc	5.26h
C6-92-u	3.33lm	30.00gh	0.28k	stork	91.11a	61.13a	8.62efg
Falat	90a	46.76b	21.94a	Sumi3	1.11m	3.33j	0.76k
Frontana mx	4.34lm	20i	0.72k	Sw893064/star	73.33bc	29.41defg	12.51c
Frontana	1.11m	3.32gh	0.44k	Tajan	50fg	26.59defg	3.79hi
koohdasht	46.67fg	23.76efgh	2.72ij	Wangshuibai	7.78klm	20gh	0.52k
Milan/amsel/cb	14.67jk	32.56cde	0.47k	yavaros	78.55b	60.01a	16.59b
Milan/shanghai	2.22m	16.67h	0.18k	Zagros	22 .22b	36cd	4.1hi
Moghan3	60.22de	31.31cde	10.33de	Zmara	80b	35.35cd	8.51fg

Numbers with the same letter, have no significant difference.

Table 2: Analysis of variance for indices of disease occurrence, severity and percentage of infected seeds.

		MS		
S.O.V.	DF	Occurrence of disease (%)	Disease severity (%)	Infected seeds (%)
Variety	29	2927.47**	510.75**	102.22**
Replication	2	107.78**	119.96**	1.51ns
Error	58	14.27	13.76	0.59
C.V.	-	10.07	12.95	14.13

** and ns significant at the 0.01 level and no significant respectively.

Table 3: Analysis of variance for morphological traits.

MS				
S.O.V.	DF	Plant Height	Peduncle length	Spikelet density
Variety	29	203.1**	47.57**	0.27**
Replication	2	21.99ns	0.46	0.005ns
Error	58	7.07	0.81	0.03
C.V.	-	3.12	2.59	8.63

** and ns significant at the 0.01 level and no significant respectively.

Table 4: Correlation coefficients between morphological traits.

	MS		
S.O.V.	Plant Height	Peduncle length	Spikelet density
Infected seeds	-0.43**	0.48**	0.12ns
Occurrence of disease	-0.51**	-0.47**	0.05 ns
Disease severity	-0.53**	-0.38*	0.14 ns
SSI Index	-0.42*	-0.47**	-0.02 ns
Sensitive factors	-0.53**	-0.51**	0.11 ns

* and ** significant at the 0.01 and 0.05 level respectively. ns no significant.

MX is a Forontana figure, the linkage between resistant elements genes to resistance to FHB probably can be considered as one of the reasons for the relationship between long-legged genotypes with resistance to FHB. Falat, Stork and Pavarse evaluated as the most sensitive genotypes, compared short-legged to long-legged genotypes, the short-legged ones in an infected natural conditions, are more sensitive to FHB, because of its close head into the earth s surface. It can be inference that the genotypes with a height of 100 cm to the crop residue soil are closer to the surface of the soil, so the spikes are closer to the source of pollution which increases the sensitivity of the disease [1].

In recent studies indicated that there is an association between the numbers of places the gene bit of resistance to FHB with places Gene little about plant height [6]. With regard to pollution in this experiment artificially created so the correlation between plant height and indices of disease continuous places gene little these traits linked in Golinski *et al*. [12] research on wheat autumn it was found that the QTL located on chromosome 5A of the sensitivity of FHB with QTL associated with plant height has a linkage that the correlation of results in this test is consistent. The results of this experiment with Ma *et al*. [7] the lin QTL linkage associated with resistance to FHB with height in the atmosphere is consistent. Negative correlation between plant height and occurrence of disease percentage agrees with the results of Choo *et al*. [6]. According to Choo *et al*. [6], one of the causes of most resistance with higher elevation is in the field experiments that the spikes of these genotypes are not surrounded by Kert spikes as sources of pollution distributor. The characteristic of long-legged in wheat is considered as an undesirable crop trait. Therefore the resistance to FHB resistance are different in a variety of different sources, so using short-legged and resistant genotype with a suitable capability of combination can be suitable for amending resistance to FHB.In spite of their being short-legged were placed in a suitable resistance genotype group against FHB. With regard to this point, in case good combining of these genotypes they can be used as sources good resistance in amending programs.There was a significant and negative correlation with 1 percentage level between the occurrence of the disease as a marker for disease resistance type one with initial infection against a disease with a peduncle length.There was a negative and significant correlation with 5 percentage between the disease severity as an indicator of resistance type two.Genotypes with longer peduncle length are more resistant to this disease and this trait is mentioned as one of the morphological traits associated to resistance to FBH [13].

In this study no significant correlation between disease and peduncle length was observed (Table 4). Rudd *et al*. [13] was mentioned that the peduncle length as a trait that is impressive both on the plant height and flowering time in the atmosphere.with this interpretation, given that spikes departure date and plant height as well as morphological traits affecting resistance to FHB have been mentioned [6, 7] therefore the negative correlation between peduncle length and sensitivity to FHB in wheat spike can be considered as a trait that is originated from the relationship of this trait with the plant height and date of spike.In order to further explore the relationship between genotype resistance on farm and peduncle length, two-dimensional diagram of the components of

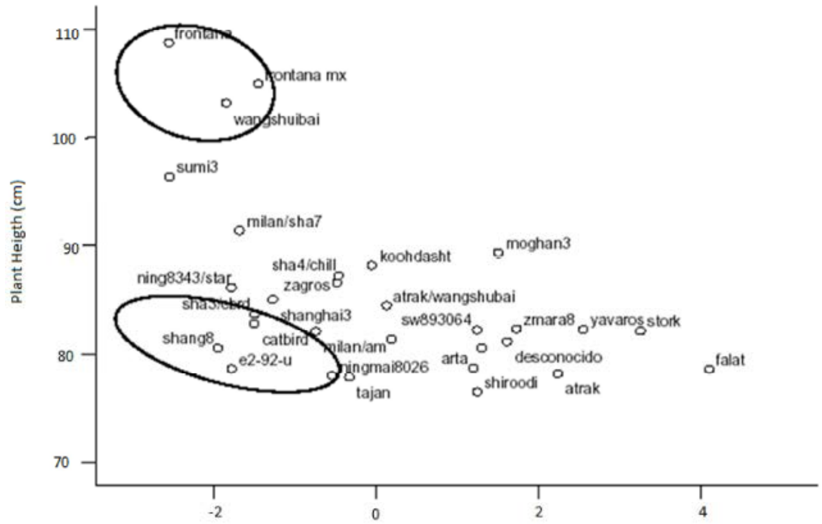

Fig. 1: Two-dimensional diagram of sensitivity of genotypes to FHB in contrast with plant height

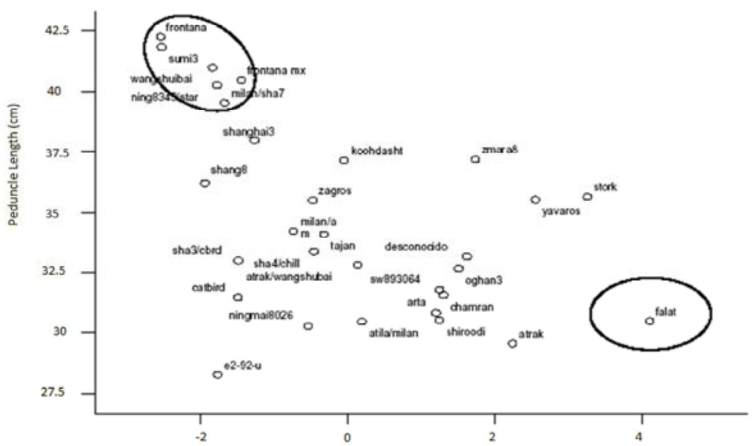

Fig. 2: Two-dimensional diagram of sensitivity of genotypes to FHB in contrast with peduncle length

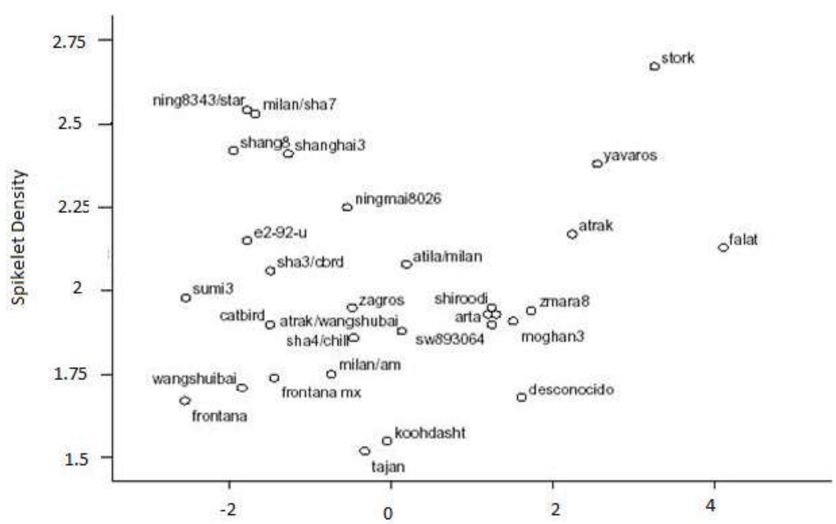

Fig. 3: Two-dimensional diagram of sensitivity of genotypes to FHB in contrast with spikelet density

susceptibility to FHB evaluated genotypes were plotted against the peduncle length (Figure 2). As can be observed Foronta and Somayterry genotypes with the lowest sensitivity component against FHB, have the most peduncle length among the evaluated genotypes. Forontana MX and Wavgshuibai genotypes, ning 8343/star and Milan/sha with relatively high peduncle length were placed among high resistant genotypes.

As can be seen the sensitive figure plateau with relatively low peduncle evaluated genotypes was classified. In spite of the negative relationship between peduncle length and sensitivity to FHB in wheat spike, the e2-92 despite the relative strength against FHB were placed in low length peduncle. Two-dimensional diagram of sensitivity component against the spikelets sensitivity was drawn. The Forontana resistance figures, MX Forontana and Wavgshuibai were placed in the lowest density spikelets figures. The sensitive Stork figure with the most density spikelets among the figures was researched. With regard to being density of the spikelets on the spikes can maintain the moisture among the spikelets, it is expected that there has been a positive correlation between the amount of compressed spikelets on the spikes and disease index [13,14]. In this experiment significant correlation between FHB resistance and density of spikelets per spike was observed. So we can choose the resistant genotypes with high density of spikelets in the selection. As it seen in (Figure 3), Shanghai Figures no. 3, Shanghais with high density spikelets was placed in relatively high resistant genotypes. As it seen in Figure 3 Shanghai no.3, Shanghai no. 8, Milan/sha7 and ning8343 figures despite of high density spikelets were placed in a relatively high resistant genotypes if the proper functioning of the other components such as spikes numbers and 10000 grain weight of these figures can be appropriate in future breeding programs as hybrids with good resistance to use of genetic resources.

CONCLUSION

In this experiment the relationship between the disease indicators with each other and morphological traits such as the plant height, peduncle length and density of spikelet on the spikes was accomplished. A significant and negative correlation was observed between plant height and peduncle length and susceptibility to FHB. The existence of long-legged in wheat crop is considered as an undesirable agronomic trait, so the correlation between these traits with resistance to FHB is not suitable for reformers.

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