*Biological Forum – An International Journal* **9**(2): 81-86(2017)

**ISSN No. (Print): 0975-1130**
**ISSN No. (Online): 2249-3239**

# Effect of Planting Date and Cultivar on Grain Yield and Disease Incidence of *Fusarium* Head Blight in Moghan Region

***Kamal Shahbazi*, Hassan Khanzadeh*, Hossein Karbalaei-khiavi** and Hossein Zeinalzadeh-tabrizi****
**Crop and Horticultural Research Department, Ardabil Agricultural and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization (AREEO), Ardabil, Iran*
***Plant Protection Research Department, Ardabil Agricultural and Natural Resources Research Centre, Agricultural Research, Education and Extension Organization (AREEO), Ardabil, Iran*

*(Corresponding author: Hassan Khanzadeh)*
*(Received 17 June 2017, Accepted 27 July, 2017)*
*(Published by Research Trend, Website: www.researchtrend.net)*

**ABSTRACT: Fusarium head blight is an important disease of wheat in the world leading to grains quality and their infection with mycotoxin in addition to yield loss. This study was conducted to determine the best planting date to avoid infection with fungus. Accordingly, five wheat cultivars (Tajan, Falat (control), Moghan 3, N-80-19 and Darya) in combination with four planting dates including 27 October, 11 November, 26 November and 11 December were examined in Moghan Agricultural and Natural Research Station for three consecutive years (2012-2014). The experiment was performed in form of split plots based on Random Complete Block Design (RCBD) with three replicates. The main plots (factors) were planting dates and the subplots were wheat cultivars. Field observations of the disease were noted during the period of growth and the effect of disease incidence on grain yield was calculated in all treatments at the end of the season. Based on the results, the highest grain yield was observed in planting date of 11 November. The study on the percentage of wheat infected with FHB indicated a significant reduction of disease from 27 October to 11 December. According to the obtained results, there was a significant yield loss in 27 October due to the increase of FHB percentage. The highest amount of grain yield was obtained in 11 November when the disease incidence was significantly reduced. In planting date 11 November, the line N-80-19 was the best treatment in terms of giving the best grain yield and minimal disease incidence of *Fusarium* head blight. In general, it is not recommended to culture earlier than 11 November in Moghan region due to the high level of FHB disease and consequently reduction in quality and product yield.**

**Keywords:** *Fusarium* head blight, Grain yield, Planting date, Wheat.

## INTRODUCTION

*Fusarium* head blight which is mainly created by the fungus *Fusarium graminearum Schwabe*, is one of the important diseases of wheat in the world (Gale, 2003; Brennan *et al*., 2005; Toth *et al*., 2008). This disease has been spread in Iran for many years and is considered as one of important wheat diseases in provinces of Mazandaran, Golestan, Zanjan, Fars and Ardabil (Moghan) (Bernusi *et al.*, 2002). Fusarium head blight has been reported in different countries such as Russia, Sweden, France, Italy, Germany, Australia, Brazil, Norway, Japan and Canada (Parry *et al*., 1995). Fusarium head blight reduces the grain weight in two ways. In infected grains, the florets are pink, white or light gray, grains are shriveled with low or without endosperm. The test weight is significantly low in these grains. In susceptible genotypes, up to 80% of florets can show such symptoms leading to apparent decline in grains weight (Bai and Shaner, 1994; Jones and Mirocha, 1999). The second effect of FHB occurs on reduction of grains weight without direct infection. When the wheat spike is infected by mycelia, oldness of florets in up and down of infected point effects on grain filling. However, reducing the grains weight is due to the fact that the amount of food intake of seeds is reduced due to the closure of vascular tissue.

This disease reduce the viability by damaging the fetus, causes the grain yield loss through reducing the number and weight of grains and creates seedling blight in next cultivation. Also, infection of grains to mycotoxins of Nivalenol, Zearalenol and Deoxynivalenol are considered as a serious threat for human and animal health (Shima *et al*., 1997; Pakdaman *et al*., 1999; Guo *et al*., 2010; Jones and Mirocha, 1999).

In recent years, this disease has been widespread in wheat fields of northern Iran due to favorable climatic conditions, especially the simultaneous presence of high humidity and dew with flowering time and grain filling as well as wide rotation of wheat and corn (Foroutan *et al*., 1991; Golzar, 1998). Agricultural control methods include the use of appropriate rotation, proper irrigation methods, optimal use of fertilizer and correct land preparation operation. However, the use of resistant cultivars and optimum panting date is the most effective method to control this disease. The use of these methods in addition to being consistent with the preservation of environment, also contain the damages of reducing quality and accumulation of mycotoxins in grain simultaneously (Miedaner *et al*., 2008). Considering the limitations of increasing the acreage of wheat, wheat yield increase can be the mainstay of practical solutions to meet the needs of the country. Live stresses such as pests and plant diseases are some of the factors reducing the wheat yield per unit area. 52 economic and major diseases have been recognized so far and FHB is one of them. This disease is one of dangerous wheat diseases in humid and warm regions of the world which cause qualitative and quantitative damages to wheat and some problems for human and animal health (Bai and Shaner, 1994).

Arthur (1981) for the first time reported the occurrence of this epidemic in 1890 from Indiana, America between 25 to 75%. Several other epidemics have been reported from the United States (Tuite *et al*., 1990). FHB disease can reduce highly the grain yield and quality and may affect the animal products directly as well (Tuite *et al*., 1990). According to Dickson and Mains (1929), severe epidemic of this disease in the United States in 1919 led to loss of about 2,880,000 tons of wheat.

One important method for controlling FHB is using cultivars resistant to the disease and applying cultivation methods such as determining optimal planting date (Parry *et al*., 1995; Knopf and Miedaner, 2008; Pierri *et al*., 2015). To this purpose, we can point the rotation and observation of cultivation, the use of healthy and certified seed, destroy Graminae weeds, lack of transporting seeds of infected regions to other regions, disinfection of seeds with one of the contact fungicides and the use of fungicides as foliar in flowering stage and repeat it if necessary (Rajabi and Behrozin, 2003).

In recent years, FHB in wheat fields of Moghan region has become a major problem. Since chemical control of this disease doesn't seem proper, the use of resistant cultivars and cultivation methods such as changing the planting date and changing the heading time of plant (escape from the disease) is considered as one of the ways to control and prevent the epidemic of this disease. This research aimed to study on different planting dates as one of cultivation methods on controlling Fusarium head blight diseases in Moghan regions.

## MATERIALS AND METHODS

This test was implemented as a split plot in form of randomized complete block design with five treatments and three replicates for three years (2011-2012, 2012-2013, 2013-2014) in trial field of Ardabil Agricultural and Natural Resources Research and Education Center, Moghan, Iran. In this study, five cultivars and wheat lines including Tajan, Moghan 3, Darya, N-80-19 and Falat (control) in planting dates of 27 October, 11 November, 26 November and 11 December were reviewed in terms of grain yield and incidence of FHB disease. Main plots were different planting dates and subplots were different cultivars. Tillage operations include deep plowing, disc, leveler and furrows in the fallowland. According to the results of soil test, 200 kg of ammonium phosphate fertilizer was used before planting and 250 kg per hectare urea fertilizer was used in three stages (50 kg at planting time, 100 kg at anthesis time and 100 kg at heading time). The test seeds in plots with an area of 20 square meters with 20 cm distance of lines and in depth of 7 cm were cultivated on the ridges with a width of 60 cm using Wintersteiger experimental seeder. Furrow irrigation was done 6 times in different growth stages wheat. Weed control was done manually with Topik and Granstar pesticides. 30 wheat areas were selected from each plot and a labeled to take note from *Fusarium* head blight before symptoms of infection. After emergence of symptoms, the number of labeled infected ears were counted and the percentage of infected ears which means the percentage of disease incidence were calculated.

Finally, the grain yield in each cultivar and different planting dates was measured in five-member samples randomly. Quantitative traits were analyzed using MSTAT-C software and the means were compared using Duncan test.

## RESULTS AND DISCUSSION

The results of analysis of variance showed that except the factor of planting date and interaction effect of planting date × the year, other factors had significant effect on grain yield at 5% levels of probability (Table 1).

Also, the effect of the three factors of year, cultivar and planting date and also their interaction except triple interaction of year × planting date × cultivar in probability level of 1% was significant on the incidence of *Fusarium* head blight (Table 1).

Comparison of the average of yield properties and infection of grains to FHB showed that the percentage of disease incidence in different wheat cultivars in the first year was at the highest and in the second year was at the lowest level. The highest amount of grain yield was obtained in the third year (7326 kg per hectare) and the lowest amount of yield was obtained in the second year (6712 kg per hectare) (Tables 2, 3 and 4).

**Table 1: Combined analysis of variance for grain yield and incidence of fusarium head blight.**

| Sources of variable S.O.V | Degree of freedom | Means Square | |
|---|---|---|---|
| | | Yield | incidence of fusarium head blight |
| Year | 2 | 22050878.97** | 918.12** |
| Error (a) | 6 | 582042.01 | 30.64 |
| Planting date | 3 | 3581925.40 $^{ns}$ | 10282.69$^{**}$ |
| Year × Planting date | 6 | 2294125.19 $^{ns}$ | 150.72 |
| Error (b) | 18 | 1228852.74 | 28.659 |
| Cultivar | 4 | 1396053.64$^{*}$ | 5715.103** |
| Year × Cultivar | 8 | 1179458.78$^{*}$ | 173.269** |
| Planting date × Cultivar | 12 | 1330523.73$^{**}$ | 672.692** |
| Year × Planting date × Cultivar | 24 | 824096.99** | 28.219 $^{ns}$ |
| Error (c) | 96 | 473135.82 | 20.128 |
| Coefficient of variables% | - | 10.24 | 26.08 |

ns, *and **: Not significant, significant at the 5% and 1% levels of probability, respectively

**Table 2: Mean comparison of yield and fusarium head blight infection percent in 3 years.**

| Year | Grain yield (Kg/ha) | Disease incidence (%) |
|---|---|---|
| **2011** | 6114c | 19.50a |
| **2012** | 6712b | 12.68b |
| **2013** | 7326a | 19.42a |

Means in each column followed by similar letters are not significantly different at 5% probability level, Using Duncan multiple range test

**Table 3: Mean comparison of grain yield and incidence of Fusarium head blight in different cultivars.**

| Cultivars | Grain yield (Kg/ha) | Disease incidence (%) |
|---|---|---|
| Falat | 6754ab | 36.94a |
| Tajan | 7005a | 21.67b |
| Moghan3 | 6598b | 13.28c |
| N-80-19 | 6748ab | 8.48d |
| Darya | 6481b | 5.64e |

Means in each column followed by similar letters are not significantly different at 5% probability level, using Duncan multiple range test.

**Table 4: Mean comparison of grain yield and incidence of *Fusarium* head blight in different years and planting dates.**

| Year | Grain yield (Kg/ha) | Grain yield (Kg/ha) | Disease incidence (%) |
|---|---|---|---|
| 2011 | 27 Oct. | 5858f | 41a |
| | 11 Nov. | 6383def | 24.33b |
| | 26 Nov. | 6098ef | 9.67d |
| | 11 Dec. | 6115ef | 3e |
| 2012 | 27 Oct. | 6872cd | 26.67b |
| | 11 Nov. | 6755d | 17.53c |
| | 26 Nov. | 6568de | 4.87e |
| | 11 Dec. | 6655de | 1.67e |
| 2013 | 27 Oct. | 7334bc | 40.67a |
| | 11 Nov. | 8124a | 25b |
| | 26 Nov. | 7414b | 9d |
| | 11 Dec. | 6431de | 3e |

Means in each column followed by similar letters are not significantly different at 5% probability level, using Duncan multiple range test.

Reviewing the effect of different planting dates on the yield process and infection percent of cultivars to FHB showed that the highest amount of yield was obtained on 11 November and there was a significant reduction during the period of 27 October to 11 December (Fig. 1). Given that Fusarium head blight has had a significant reduction on 11 November and was lower than the damage threshold, the highest yield amount was obtained and there was a significant yield reduction on 27 October due to the increase of the disease percentage. Comparison of the interaction of planting date × cultivar showed that in cultivation date of 11 November, the wheat line N-80-19 was the best treatment in terms of crop yield and the incidence of Fusarium head blight. Comparison of the mean of grain yield and disease incidence of FHB in different cultivars showed that the highest and the lowest disease incidence was respectively related to Falat and Darya cultivars and the highest grain yield was related to Tajan cultivar (Table 5 and 6). Comparison of the mean of these traits affecting by the year and planting date also indicated the significant impact of these two factors and their interaction on the studied traits (tables 1, 2 and 4). It was so that the lowest disease incidence with significant difference in each of the three years has been related to the last planting date and this indicates an increase in the level of disease in early cultures.

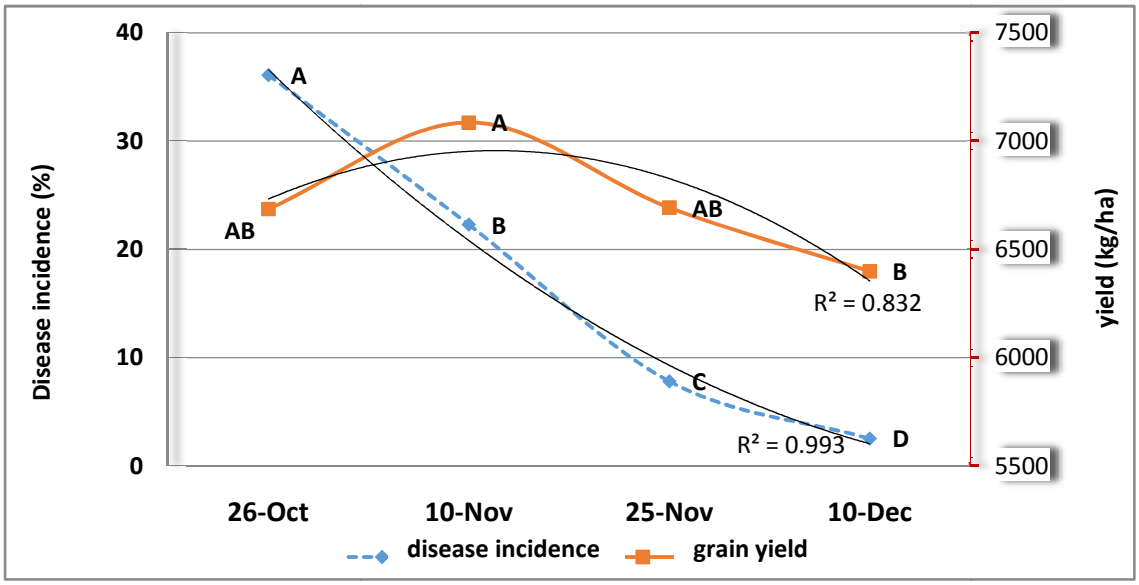


**Fig. 1.** Mean of grain yield and incidence of fusarium head blight.

**Table 5: Mean comparison of grain yield and incidence of Fusarium head blight in different years and cultivars.**

| Year | Cultivars | Grain yield (Kg/ha) | Disease incidence (%) |
|---|---|---|---|
| | Falat | 5970 f | 43.33a |
| | Tajan | 6175 f | 24.17b |
| 2011 | Moghan3 | 6150 f | 12.92cd |
| | N-80-19 | 6364 ef | 10de |
| | Darya | 5908f | 7.08ef |
| | Falat | 7023abcd | 25.42b |
| | Tajan | 7196abc | 16.67c |
| 2012 | Moghan3 | 6792cde | 13.58cd |
| | N-80-19 | 6439def | 5fg |
| | Darya | 6113f | 2.75g |
| | Falat | 7270 abc | 48.08a |
| | Tajan | 7644a | 24.17b |
| 2013 | Moghan3 | 6853bcde | 13.33cd |
| | N-80-19 | 7441 ab | 10.42de |
| | Darya | 7422 abc | 7.83ef |

Means in each column followed by similar letters are not significantly different at 5% probability level, using Duncan multiple range test.

**Table 6: Mean comparison of grain yield and incidence of *Fusarium* head blight in different planting dates and cultivars.**

| Year | Cultivars | Grain yield (Kg/ha) | Disease incidence (%) |
|---|---|---|---|
| 27 Oct. | Falat | 6770abcde | 67.78a |
| | Tajan | 7193abc | 48.89b |
| | Moghan3 | 6783abcde | 27.78c |
| | N-80-19 | 5895f | 20.56d |
| | Darya | 6800abcde | 15.56e |
| 11 Nov. | Falat | 7148abcd | 51.11b |
| | Tajan | 7475a | 26.11c |
| | Moghan3 | 6647bcdef | 17.22de |
| | N-80-19 | 7381ab | 10f |
| | Darya | 6785abcde | 7fg |
| 26 Nov. | Falat | 6551cdef | 18.33de |
| | Tajan | 7177abc | 10.56f |
| | Moghan3 | 6373def | 7fg |
| | N-80-19 | 6981abcd | 3.33gh |
| | Darya | 6383def | 0h |
| 11 Dec. | Falat | 6549cdef | 10.56f |
| | Tajan | 6174ef | 1.11h |
| | Moghan3 | 6590cdef | 1.11h |
| | N-80-19 | 6735abcde | 0h |
| | Darya | 5954f | 0h |

Means in each column followed by similar letters are not significantly different at 5% probability level, using Duncan multiple range test.

Therefore, a level of disease where the highest yield is obtained during the three years can be suggested. Simultaneous study of yield traits and disease incidence affected by different planting dates (figure 1) showed that the yield has been reduced before 11 November and disease incidence has been increased.

## CONCLUSION

It can be concluded that in early planting dates, the incidence of Fusarium head blight is increased and the yield is decreased and in fact in addition to increasing the costs of chemical control, the farmer income is also reduced. However, in late planting date, despite the low level of disease, the product yield is also reduced. According to this study, the cultivar had also significant impact on FHB incidence. The study of the disease incidence indicated a significant reduction of the disease from 27 October to 11 December. In planting date of 11 November, the line N-80-19 was the best treatment in terms of yield and infection to Fusarium head blight. In general, in order to obtain high yield and acceptable disease incidence, cultivation of cultivars resistant to the disease in appropriate planting date range is recommended; particularly in the range of 11 November in Moghan region for relative escape from Fusarium head blight.

## REFERENCES

Arthur JC, (1891). Wheat scab. *Indiana Agricultural Station Bulletin*, **36**: 129-138.

Bai GH and Shaner G, (1994). Scab of wheat: prospects for control. *Plant Disease*, **78**: 760-765.

Bernusi I, Ghanadha MR, Omidi M, Samadi BY and Hosseinzadeh A, (2002). Inheritance of resistance to fusarium within a spike of wheat. *Pajouhesh and Sazandegi.* **63**: 57-62. (In Persian).

Brennan JM, Egan D, Cooke BM and Doohan FM, (2005). Effect of temperature on head blight of wheat caused by Fusarium culmorum and F. graminearum. Plant Pathology, **54**: 156-160.

Dickson JG and Mains EB, (1929). Scab of Wheat and barley and its control. *US Department of Agriculture, Farmers Bulletin*, **1599**: 1-17.

Froutan A, Ershad J, Dalili A, Bamdadian T and Gerami G, (1991). Epidemi of wheat scab in Mazandaran. Proceeding of the 11th Iranian Protection Congress, Rasht, IRAN. PP:130. (In Persian).

Gale LR. (2003). Population biology of Fusarium species causing head blight of grain crops. In: K. J. Leonard and W. R. Busnell (eds). *Fusarium* Head Blight of Wheat and Barley. *The American Phytopathological Society, St. Paul, MN*. **15**. pp:120-143.

Golzar H. (1998). Wheat scab disease, Evaluation of disease factor, ways of infection and transmission by seed. *Plant Diseases.* **25**: 17-22.

Guo XW, Fernando WGD, Bullock P and Sapirstein H, (2010). Quantifying cropping practices in relation to inoculum levels of *Fusarium graminearum* on crop stubble. *Plant Pathology*, **59**: 1107-1113.

Jones RK and Mirocha CJ, (1999). Quality parameters in small grains from Minnesota affected by *Fusarium* head blight. *Plant Disease*, **83**: 506-511.

Knopf C and Miedaner T, (2008). Variation of aggressiveness of *Fusarium graminearumon* highly resistant and susceptible spring wheat. *Cereal Research Communication.* **36**: 635-636.

Miedaner T, Wilde F, Korzun V and Ebmeyer E, (2008). Phenotypic selection for high resistance to *Fusarium* head blight after introgression of quantitative trait loci (QTL) from exotic spring wheat and verification by simple sequence repeat markers a posteriori. *Plant Breeding*, **127**: 217-221.

Pakdaman B, Mohammadi Gol Tapeh E, Alizade A and Allame AA, (1999). Effect of Fusarium fitotoxin in wheat seed seedling in wheat tolerance scab fusarium. Proceeding of the 14th Iranian Protection Congress. Esfahan, IRAN. PP: 6. (In Persian).

Parry DW, Jenkinson P and Mcleod I, (1995). Fusarium ear blight (scab) in small grain cereals a review. *Plant Pathology*, **44**: 207-238.

Pierri S, Denis AS, José Maurício CF, Gary CB and Emerson M, (2015). Disease risk, spatial patterns, and incidence-severity relationships of Fusarium head blight in no-till spring wheat following maize or soybean. *Plant Disease.* **99**(10): 1360-1366.

Rajabi G and Behrozin M, (2003). Wheat Guide (pests and diseases and methods of combating them). *Research and Education Organization*. pp 153. (In Persian).

Shima J, Shigehiro T, Yoko T, Yuzuru I, Haruhiro F, Yamazaki M and Kozo O, (1997). Novel detoxification of the trichothecene mycotoxin deoxynivalenol by a soil bacterium isolated by enrichment culture. *Environment Microbiology*, **63**: 3825-3830.

Toth B, Kaszonyi G, Bartok T, Varga J and Mesterhazy A, (2008). Common resistance of wheat to members of the *Fusarium graminearum* species complex and *F. culmorum*. *Plant Breeding.* **127**: 1-8.

Tuite J, Shaner G and Everson RJ, (1990). Wheat Scab in soft red winter wheat in Indiana in 1986 and its relation to some quality measurements. *Plant Disease*, **74**: 595-962.