Host response of some wheat cultivars to stem rust disease incited by *Puccinia graminis* f. sp. *tritici* under Sulaimani conditions

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Abstract

Wheat stem rust caused by the fungus (*Puccinia graminis* f. sp. *tritici*) is historically the most damaging disease of wheat (*Triticum aestivum*). In the worst cases, yield losses of 70% or more are possible. It was at one time the most feared disease of the wheat crop. In the present study, twenty-two wheat genotype (14 Bread Wheat, 6 Durum Wheat, and 2 Triticale cultivars) were tested to investigate the host reaction between the cultivars with the pathogen population of *P. graminis* f.sp *tritici* under natural inoculation conditions. Based on the results of disease severity and coefficient of infection, the high resistance reaction was found in bread wheat cultivars Maaroof and Charmo, and Triticale wheat cultivars Rezan and Sarah, while bread wheat cultivars Adana and SaberBeg and durum wheat cultivars Cimmito and Acsad explored high resistance against the pathogen population of *P. graminis* f.sp *tritici,* at adult plant stage in the field.

Keywords: *Triticum aestivum* - Fungal diseases - *Disease resistance* - *Puccinia graminis* f. sp. *tritici* - *Iraq.*

استجابة العائل لبعض أصناف القمح لمرض صدأ الساق المتسبب عن الفطر *Puccinia graminis* f. sp. *tritici* في ظروف السليمانية

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خلاصة:

يعد مرض صدأ ساق القمح الناجم عن الإصابة بالفطر (*Puccinia graminis* f.sp. *tritici*) من أكثر ألامراض ضرراً على محصول القمح (*Triticum* aestivum)، حيث يتسبب عن فقدان اكثر من 70 ٪ من حاصل الحبوب. عرف المرض بكونه من اكثرالأمراض ضرر افي محصول القمح عبر الزمن. تم اختبار استجابة رد فعل العائل ل 22 صنف وتركيب وراثي من القمح في هذه الدراسة(14 منها يعود لحنطة الخبز، 6 منها حنطة معكرونة و صنفين من القمح الشيلمي) للتحقق من تفاعل العائل بين هذه الأصناف مع مجتمع مسبب المراض *P. graminis f.sp tritici* تحت ظروف العدوى الطبيعية. آظهرت نتائج دراسة تفاعل العائل المقاومة العالية في اصناف القمح الطري معروف وجرمو، وآصناف القمح الشيلمي ريزان وسارة بناءً على نتائج شدة الاصابة ومعامل الإصابة بالمرض، في حين أظهرت أصناف القمح الطري أدنة، صابربيك والقمح القاسي سميتوا و اكساد مستويات عالية من الحساسية للمرض في مرحلة النبات البالغ في الحقل.

الكلمات المفتاحية: *Triticum aestivum* – امراض فطرية – مقاومة المرض – *Puccinia graminis* f. sp *tritici* - العراق.

Introduction

Wheat (*Triticum aestivum* L.) is a staple food for millions of people across the globe, especially in Iraq. It is cultivating in a wide range of arid and semi-arid areas, However, due to climate change the productivity of wheat has decreased from 8-10% in many wheat-growing areas in the world (10). Most of the current wheat cultivars belong to hexaploid wheat, which is known as bread wheat and valued for bread making (19). Wheat quality is dependent upon the genetic factors, soil composition and environmental factors including temperature, rainfall, planting date, humidity etc. (16).

To increase wheat production, high yielding cultivars with a diverse genetic base and the ability to produce higher yields under a variety of agro-climatic conditions, as well as greater disease resistance, must be developed (5). Many diseases can attack wheat, mainly caused by fungi, bacteria, and viruses. The main important wheat-diseases in Kurdistan region can be categories to seed-borne diseases including common bunt (stinking smut), loose smut, and seed gall disease (4); airborne diseases including yellow rust, leaf blotch, stem rust and barley yellow dwarf virus disease (4, 8). Great efforts have been made to increase wheat production by developing high yielding cultivars with a diverse genetic base and the ability to produce higher yields under a variety of agro-climatic conditions, as well as greater disease resistance (19, 21, 22).

Stem Rust of wheat is an occasional, but it is devastating disease of wheat. Epidemics occur when there is a carry-over of stem rust from the previous season, susceptible varieties of wheat are grown, and warm humid conditions in the spring encourage disease development (15). Stem Rust is the dreaded disease, the most important wheat disease globally causes severe grain shriveling, stem breakage total losses caused by the pathogen *Puccinia graminis* f. sp. *tritici* under heavy epidemic drastically reduce growth and yield up to 70% under control in most regions except East Africa since Green Revolution (20). Disease Symptoms on infected plants commonly appears on stems, leaf sheath and leaf blade; occasionally parts of the head. Shape and distribution of lesions oval or elongated pustules flecks soon develop as oblong, reddish brown uredo-pustules, scattered on affected tissues, lesions visible on both side, lesions color orange- Red. Degree of damage tearing of outer layer of plant tissue that is visible without magnification. Breeding for resistance is the most practical and economic method to control such disease (18). These methods are environmentally safe and do not require disease control input from growers. This is very important especially in the areas where farmers have not adequate resources to purchase and apply chemicals particularly in Kurdistan region. Stem rust was not a serious problem in Kurdistan regions, it was usually distributed in the central and southern parts of Iraq (2). Recently high stem rust infections were detected in some wheat fields in Kurdistan and other northern parts of Iraq. It threatens wheat production under the scenario of the new race Ug99 movement ahead in the region towards Iraq along the *Yr9* virulence pathway (7). Extensive surveys were conducted annually in wheat fields of Iraq for monitoring of Ug 99 race group and other Pgt races. Al-Maaroof 2017 (3), identified 5 physiological races of *P. graminis* f. sp. *tritici*, Race TKTRC which was prevalent in Sulaimani*;* RKJTF in Erbil*;* TKTTC in Nineveh*;* PRJSC in Diala and KRKSC in Dheqar. More recent races TKKTF, TKTTF and TTKTT were confirmed for the first time in Iraq and middle east (13). The current study was aimed to evaluate the host response of different wheat cultivars to stem rust infection under natural inoculation and field conditions.

Materials and Methods

The study was conducted on experimental field of college of agricultural engineering sciences, Sulaimani University (Lat: N 35˚ 32 036; Long: E 45˚ 21 865; Alt: 726m) during the winter season of 2017-2018. Twenty-two wheat genotype (14 Bread Wheat, 6 Durum Wheat and 2 Triticale) were cultivated in a Completely Randomized Block Design (CRBD) with three replicates, the experimental units were presented by two lines of 2m long/cultivar with 20 cm apart within

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rows. The treatments were randomly distributed in each block with 40cm space between treatments and two meters between blocks. Bread wheat cultivars included cvs, Adana, SaberBeg, Araz, Tamuz 2, Alaa, Ipa99, Maaroof, Sulaimani 2, Sham 6, Sham 8, Rezgari, Hsad, Charmo and Babel 113, while duram wheat cultivars consist of Cimmito, Acsad 65, Sham 5, Om Rabea, Waha and Creso; Triticale cultivars consist of Sarah and Rezan. The seed rate was 140kg ha^{-1} in rows within the blokes. DAP fertilizer (46% P, 18% N) (Saudi Arabia product) was added to the soil at sowing as recommended dose (174 Kg ha^{-1}) and nitrogen fertilizer as the form of Urea (46%N) (Saudi Arabia product) was applied at sowing and tillering by 63 Kg ha^{-1} and 130 Kg ha^{-1} respectively. The field was entirely surrounding with three line of a mix of susceptible cultivars as a trap and spreader of *P. graminis* inoculum in the field (8). Disease scoring were conduct at adult plant stage in the field by determining the infection type according to the modified Cobb-scale (14), Where 0 = no visible infection; R= Resistant, yellow, chlorotic or necrotic area with or without small pustules; MR= moderately resistant, small pustules surrounded by chlorotic or necrotic areas, M= intermediate (mesothetic); pustules of variable sizes with some chlorosis or necrosis, MS= moderately susceptible, medium sized pustules, no necrosis but some chlorosis possible, S= susceptible, large pustules, no necrosis or chlorosis. While the disease severities were determined as the percentage of possible tissues rusted. The coefficient of infection (C.I) of yellow rust on each cultivar was calculated by multiplying the severity times with a constant value given to the host response; where immune (I) =0.0, R=0.2, MR=0.4, M= 0.6, MS =0.8 and S=1.0. This makes it easy to rank or statistically compare between genotypes or nurseries (15).

C. I = DS *IT

Where, DS= Disease severity and IT= Infection Type

All the data were statistically analyzed at p=0.05 significant levels using analyses of variance (ANOVA). LSD at 5% level were used to compare between the mean of the traits.

Results and discussion

Results show a wide range of host reaction between the tested bread wheat cultivars with the pathogen's population of *P. graminis* f.sp *tritici* started from high resistant reaction in Maaroof and Charmo cultivars to high susceptibile in Adana and SaberBeg, susceptible in Aras, Tamuz 2, Ipa', Sulaimani 2, Sham 6, Rezgari and Babil 113, Moderate susceptible in Sham 8 and Hsad and moderately resistance in Alaa (Table1). Furthermore, high significant differences were observed between the tested genotypes in disease severities (DS) and coefficient of infection (CI) values, the highest values of DS & CI were recorded on SaberBeg and Adana which was 78.3 in SaberBeg followed by 76.7 in Adana, while the lowest value of DS & CI was recorded on Charmo which was 0.0 followed by 45.3 and 1.06 respectively in Maaroof. Coefficient of infection and disease severities values in SaberBeg significantly surpassed all other tested genotypes except Adana.

Results in Table (2) indicates that five categories of host reaction between the tested durum wheat and triticale cultivars with the pathogen population of *P. graminis* f.sp *tritici* were detected starting from high resistance reaction in Triticale cultivars Rezan and Sarah cultivars to high susceptibility in Cimmitto, Susceptible categories included durum wheat cultivars Acsad 65 and Waha, Moderate susceptible category in Sham 5 and Criso and Moderate resistant category in Om Rabea cultivar. Furthermore, high significant differences were observed between the tested genotypes in disease severities and coefficient of infection value, the highest values of DS & CI were recorded on Cimmtto which was 79.67 followed by 73.16 in Waha, while the lowest value of DS & CI was recorded on Rezan which was 0.0 followed by 3.30 and 0.66, respectively in Sarah. Coefficient of infection and disease severities values in Cimmitto significantly surpassed all other tested genotypes except Waha.

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Table 1. Host reaction of different bread wheat cultivars against *P. graminis f.sp tritici* population under natural inoculation conditions in Sulaimani during 2018.

Genotype	Infection Type (IT)	Disease Severity % (DS)	Coefficient of Infection (CI)
Adana	HS	76.7	76.7
SaberBeg	HS	78.3	78.3
Aras	S	63.3	63.3
Tamuz 2	S	53.7	53.7
Hsad	MS	26.7	21.36
Ipa'99	S	65.6	65.6
Maaroof	R	5.3	1.06
Sulaimani 2	S	43.0	43.0
Sham 6	S	60.0	60.0
Sham 8	MR	22.3	8.92
Rezgari	S	48.7	48.7
Alaa	MR	20.0	8.8
Charmo	R	0.0	0.0
Babil 113	S	55.2	55.2
Mean	-	**44.20**	**41.76**
LSD 0.05	-	**12.16**	**8.3**

Table 2. Host reaction of different durum wheat and triticale cultivars with *P. graminis f. sp. tritici* under natural inoculation conditions during 2017/18.

Genotype	Infection Type (IT)	Disease Severity % (DS)	Coefficient of Infection (C.I)
Cimmito	HS	79.67	79.67
Acsad 65	S	55.26	55.26
Sham 5	MS	43.33	34.66
Om Rabia	MR	33.66	13.46
Waha	S	73.16	73.16
Creso	MS	29.63	23.70
Sarah	R	3.30	0.66
Rezan	R	0.00	0.00
Mean	-	39.75	35.07
LSD 0.05		9.3	8.2

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The high disease severity and infection type of *P. graminis f.sp tritici* on the susceptible wheat cultivars under Sulaimani conditions (Tables1&2) may be resulted from the favorable environmental conditions in this area (Fig. 1). The high precipitation during February and continuous repeated rains during April and March, resulted from high relative humidity ranged from 74-77%. While the mean temperature ranged from 21-22.5˚C which stimulated the establishment and development of the disease on the susceptible wheat cultivar. The environmental conditions are the most critical factor for the host-pathogen interaction system in the presence of pathogen virulence and the susceptible tissue (9). Water on the leaf surface from intermittent rain or heavy dews and temperatures conducive for germination and growth of the pathogen are required for disease development. Stem rust is a warm temperature disease that develop optimally between 18-29˚C, however the disease can occur at temperatures between 15-40˚C (12).

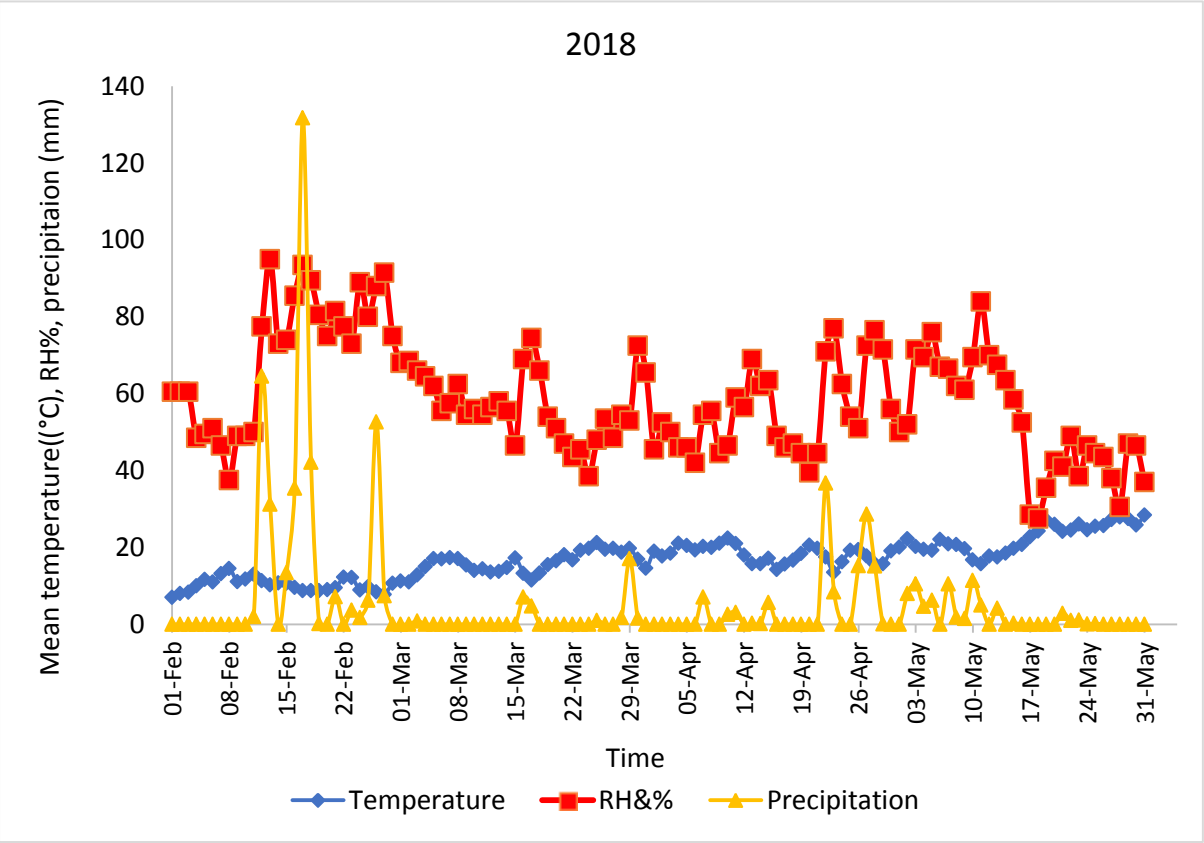

Figure 1. Mean Temperature "˚C", relative humidity "RH%" and precipitation "mm" from the 1st march to the end of May, 2018. (Weather Directorate, Sulaimani, 2018)

Results of the study encourages the selection of best resistant wheat cultivars after multi location yield trail and tests under the potential of rust disease in different Iraqi wheat growing areas. The susceptible wheat cultivars should also be excluded or cultivated in limited areas to avoid severe epidemics of rust eliminating the amount of losses cause by the disease (1, 6). We believe that the resistant genotypes will bring a difference in wheat productivity since rust disease is a major problem of wheat production in Iraq (2). Accelerating in seed delivering process of the rust resistant wheat genotypes to the farmers will effectively contribute in increasing grain yield potential in Kurdistan region.

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Conclusions

In conclusion, the results of this study show high significant differences between the tested wheat cultivars in their infection types, disease severities and coefficient with infections against stem rust disease under sulaimani conditions. Five group of host reaction to stem rust disease were detected among the tested cultivars under natural inoculation conditions in Sulaimani started from high susceptibe to resistant. The promising bread wheat cultivars Charmoo, Maaroof, Hsad and Sham 8 were significantly surpassed all other genotypes in their response to stem rust disease while Adana and SaberBeg showed high susceptibility. The promising triticale cultivars Rezan and Sarah were resistant to stem rust disease and significantly surpassed all other cultivars while Cimmeto, Waha and Acsad 65 were highly susceptible to susceptible to the disease.

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