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GROWTH ASPECTS, YIELD AND RUSTS INFECTION FOR SOM WHEAT CULTIVARS (*Triticum aestivum* L.) AS AFFECTED BY SOWING DATES

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ABSTRACT

A two-year field experiment (1997 and 1998) was carried out to study rusts infection and growth aspects for wheat cultivars (Giza 157 and 161, Gemmiza 1 and Sakha 8 and 69) as affected by sowing dates (5 and 20 November in addition to 5 December). Sowing date resulted in significant effects for all studied characters, except for leaf rust, in 1997, spike length and number of grains / spike over the two seasons.

Rusts infection had the lowest records with the earlier sowing date (5/11) in both seasons. The intermediate date of sowing (20/11) exhibited the highest grain yield/ha., number of spikes m^{-2} and 100-kernel weight (averaged out 0.14 and 0.44g compared to early and late sowing, respectively).

Differences among cultivars were significant for all studied characters, except for 100-kernel weight. Giza 161 cv. highly responded to rusts (29.52 and 51.82% for leaf and stem rusts, respectively) and produced the lowest grain yield/ha (4.47 t). Gemmiza 1 was exposed to lesser leaf and moderate stem rusts infection (5.1 and 19.2% for leaf and stem rusts, respectively as averages of both seasons) and gave the maximum records for spike length and number of grains/spike. Sakha 8 suprassed all cultivars in grain yield/ha. (7.29 t) and number of spikes m^{-2} (408.74) as averages of both seasons.

Sowing date x cultivar interaction was significant for leaf rust (in 1998) and stem rust in addition to grain yield/ha. over the two seasons. Giza 161 was highly reacted to leaf (58.33%) and stem (64.54%) rusts for early sowing dates, respectively. On the other hand, Sakha 8 produced the highest grain yield (7.93 t/ha.) with the intermediate (20/11) sowing date.

INTRODUCTION

Good yield and yield attributes performance for wheat (*Triticum aestivum* L.) has been reported to be as a result of different factors. Sowing date and high yielding cultivar and cultivars of the least reliability to the attack of diseases and pests are ones of such factors.

Stem rust (P. graminis tritici) is regarded as the most serious rust disease of wheat (El-Daoudi *et al.,* 1990; Zwer *et al.,* 1992 and Atteia and Nawar, 1994). However, leaf rust infection (P. recondita) is considered one of the important diseases in wheat growing areas (Atteia and Nawar, 1994). Prevalence of such diseases depends upon the duration of favourable conditions, affected by genotypes (Zillinsky, 1983; El-Daoudi *et al,* 1990; Salazar Huerta *et al.,* 1993 and Auestin *et al.,* 1994) and cultural practices (Singh and Avir, 1989 and Atteia and Nawar, 1994).

Early sowing has provided an escape mechanism by which rust infection and crop damage are reduced (Schlehuber and Tucker, 1967).

From the another standpoint of view, optimum sowing date is defined as a manipulation in planting time to an extent of more optimal environment for the variety to be high yielding and of unfavourable conditions for rusts infestation.

Delaying in sowing date reduced the number of spikes/m^2 and grains/spike; spike length; 1000-grain weight and grain yield (Assey *et al.,* 1986; Kumar and Kumar, 1997 and Hassan and Gaballah, 1999). Pal *et al.,* (1996) reported that sowing wheat after 24 November reduced the grain yield by 37.5 kg/ha per day. In addition, Abdel-Gawad *et al*., (1997) stated that the sowing date delay after the first of November caused a significant reduction in wheat grain and straw yields; 1000-kernel weight; number of kernels/spike and number of spikes/m^2. Hassan and Gaballah (1999) revealed that delaying sowing date from 10-30 November caused significant reduction in number of spikes/m^2; number of grains/spike; 1000-grain weight and grain yield/fad.

With respect to wheat-rust infection, Salazar Huerta *et al.* (1993) indicated that inoculated wheat with Puccinia recondita uredospores led to losses in yield that increased from 3-59%, compared with the control treatment.

Significant differences in yield and yield attributes of Egyptian wheat cultivars were reported by Nigm and Eissa (1988a); Bassiouny *et al.,* (1993); Kishk *et al.,* (1994); Hassan and Bassiouny (1995); Hassan (1998) and Khattab (1998).

Sowing date x cultivar interaction was observed for grain yield and 1000-grain weight (Assey *et al.,* 1986 and Hassan and Gaballah, 1999). The aim of this investigation was to study the effect of sowing date and cultivars on wheat yield and yield attributes performance and susceptibility to leaf and stem rust diseases.

MATERIALS AND METHODS

This experiment was laid out during 1997/98 and 1998/99 seasons at the Agriculture Research Station, Alexandria University to study the effect of sowing dates and cultivars on yield and yield components in addition to leaf and stem rust susceptibility of different wheat cultivars. Soil chemical analysis indicated values of 8.3; 1.23% and 0.02 for pH, organic matter and total nitrogen, respectively. A split-plot design with three replications was used. Main plot was allocated to three sowing dates (i.e., 5/11, 20/11 and 5/12), while the sub plots were assigned to five wheat cultivars of Giza 157 and 161; Gemmiza 1 and Sakha 8 and 69. Each experimental units (each includes 10 rows of 3.5m. long and 0.3m. wide) were surrounded by rust spreader border sown with mixtures of high susceptible cultivars to rust. All other agricultural practices were applied as recommended for wheat in the region.

At heading the rust spreader border were artificially inoculated, over the two seasons, with rust stem-uredispores. Also, spraying of leaf rust was applied. High humidity was maintained by one or two additional irrigations. Records of infection estimates were taken according to Stakman *et al.* (1962) for stem rust and to Chester (1946) for leaf rust. At harvest, the following characters were estimated for each sub-plot:

1) Number of spikes/m^2.
2) Spike length (cm.) and number of grains/spike, as an average of ten spikes taken at random.
3) 100-kernel weight (g), as an average of five samples taken at random.
4) Grain yield (t/ha.) (on the whole plot basis).

Data were statistically analysed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Analysis of variance for the studied characters in both seasons is presented in Table (1). Sowing dates significantly affected leaf rust severity, in 1998 season, in addition to stem rust incidence, number of spikes m^{-2}, 100-kernel weight and grain yield/ha over the two seasons.

Cultivars exhibited significant variations for the studied characters except for 100-kernel weight in both seasons.

Furthermore the two factor interaction (sowing dates X cultivars) reached the significance level for leaf rust, in 1998, as well as stem rust severity and grain yield/ha. over the two seasons.

Prevalence of leaf rust in (1998) and stem rust (in the two seasons) significantly increased with delaying sowing dates from either early (5/11) or intermediate (20/11) sowings to late planting of 5/12 (Table 2). Infection severity of stem rust was higher in 1997 than 1998, whereas leaf rust-incidence damage was similar over the two seasons. This may be due to more favourable conditions for stem rust predominance in the first season (Atteia and Nawar, 1994). These results were in accordance with those reported by Salazar Huerta *et al.* (1993) who reported that increasing sowing date delay increased wheat-susceptibility to rusts' infection. Leaf rust incidence increases with late sowing (compared to the first one) were 53.0% for 1997 and 263.1% for 1998. In addition, the corresponding increases of stem rust were 128.2% and 62.5% in the two seasons, respectively. These results may be attributed to the maximum adaptation in the prevailing environment to leaf and stem rusts infection (Schlehuber and Tucker, 1967). Variations among sowing dates indicated that the number of spikes/m^2 and 100-kernel weight had the same trend over the two seasons. The intermediate planting of wheat (20/11) against the early one (5/11) gave the highest values for such traits. Meanwhile, a month delay, i.e., from the first sowing date (5/12), was associated with the lowest records for the number of spikes/m^2 and 100-kernel weight. These results agreed with those obtained by Abdel-Gawad *et al.,* (1997) who reported that sowing after the first to 20 November exhibited reductions in number of spikes/m^2 and 100-kernel weight. Data obtained might be attributed to the balance between vegetative and reproductive growth with a maximum adaptation in the prevailing conditions (Gomez-Macpherson and Richards, 1995) in the case of 20 November compared to the other sowing dates.

In addition, trends for spike length and number of grains/spike were the same over the two seasons. First, compared to late, sowing resulted in the highest estimates for such traits. Hassan and Gaballah (1999) showed that delaying sowing to the period after 10 November caused declines in spike length and number of grains/spike. There was a tendency towards a mutual compensation in yield components, i.e., number of spikes/m^2, number of grains/spike and 100-kernel weight. Increasing the number of spikes/m^2 and 100-kernel weight corresponded a decrease in a number of grains/spike (and vise versa) over the three sowing dates.

Grain yield/ha behaved as the same as number of spikes/m^2 and 100-kernel weight (Table 2). Although it was the highest in 20 November-sown wheat (followed by early November sowing date), it declined with later sowing. Such decline might be attributed to a decrease in both the number of spikes/m^2 and in one kernel weight (Joseph *et al.* 1985), in addition to wheat damage as a result of heavy rusts infection (Salazar Huerta *et al.* 1993). Grain yield increase for intermediate sowing date (20 November) averaged 0.56% over the two seasons per day delay of earlier sowing date (5 November). However, yield reduction estimated at 1.57% as an average of the two seasons per one day delay in sowing after 20 November.

Differences among cultivars were significant for the studied traits except for 100-kernel weight in both seasons (Table 2). Values of leaf rust severity were almost similar over the two seasons, whereas severity for stem rust was greater in 1997 than 1998 season. This may be attributed to the more favourable conditions, prevailing in the first season, for stem rust severity. Cultivars differential response to rust incidence showed that this characteristic is a genotypically dependent and there are differences in pattern of response to such diseases (Jedel and Helm, 1994 and Khalil *et al.,* 1999). Response to leaf rust for Giza cultivars (157 and 161) was greater, but lower for Sakha cultivars (8 and 69) and Gemmiza 1 cultivars. Meanwhile, reaction of Sakha 69 and Sakha 8 cv. for stem rust infection was lower, but greater with Giza 161 relative to the other two cultivars, i.e. Giza 157 and Gemmiza 1.

Variations among the studied cultivars in yield components, i.e. number of spikes/m^2, number of grains/spike and 100-kernel weight had the same trend over the two seasons, but the differences among the five cultivars didn’t reach to the significance level for 100-kernel weight in both seasons. There was a tendency towards a mutual compensation, observed among these components. Increasing number of spikes/m^2 and number of grains/spike for Giza 157; Sakha 8 and 69 cultivars was associated with reduction in kernel weight. However, Giza 161 cultivar produced the reverse correspondings.

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In addition, generally there is a trend of decreasing number of spikes/m^2 in view of increasing number of grains/spike and grain weight.

Sakha 8 cultivar produced larger number of spikes/m^2, but Giza 161 produced lower one compared to the other cultivars. Average number of spikes/m^2 over the two seasons were 408.7 and 308.6 for Sakha 8 and Giza 161, respectively. Gemmiza 1 produced the highest number of grains/spike, however Giza 161 was the lowest in such trait. Average number of grains/spike over the two seasons were 59.39 and 39.20 for Gemmiza 1 and Giza 161, respectively. On the other hand, 100-kernel weight for Giza 161 was the highest and Giza 157 and Sakha 69 gave the lowest values, but the differences among the five studied cultivars didn't reach the significance level in the two seasons. These results were in harmony with those reported by Joseph *et al.,* (1985) and Ercoli and Masoni (1995) who indicated the mutual compensation among yield components, i.e. number of spikes/m^2, number of grains/spike and kernel weight of wheat. Cultivars could be arranged in descending order (over the two seasons) of Sakha 8, Sakha 69, Gemmiza 1, Giza 157 and Giza 161. These results could be explained by the higher number of spikes/m^2 (produced by Sakha 8 and Sakha 69 compared to the other cultivars) that compensated the lower values of the other yield attributes (i.e. number of grains/spike and grain weight).

Concerning spike length, wheat cultivars under study had the same trend for the two seasons taking into consideration that Gemmiza 1 produced longer spikes, but such trait was shorter in Giza 161 compared to the other cultivars. Spike length of Gemmiza 1 and Giza 161 were (10.12 and 8.13 Cm.), respectively as an average of the two seasons (Table 2).

Sowing date X cultivar interactions (Table 3) significantly affected leaf rust disease only in 1998 season. There was a tendency towards increasing such trait for Giza 157 and 161 cultivars by delaying sowing dates from 5/11 to 5/12. Meanwhile, such interaction exhibited inconsistent trend for each of Gemmiza 1, Sakha 8 and 69 cultivars between 5/11 and 5/12 sowings. Giza 161 gave the extreme records for leaf rust pathogenic interaction, i.e the highest at 5/12 but the lowest at 5/11 and 20/11 sowing dates.

Combination of cultivar and sowing date had significant effect on stem rust infection over the two seasons. It was evident (in 1997) that severity trend was consistent (severity reduction within 5/11 to 5/12 period) for Giza 157, 161 and Sakha 69 cultivars. However it was inconsistent for Gemmiza 1 and Sakha 8 cultivars. Data, also indicated an inconsistent trend for interaction effect on stem rust severity in 1998. In general, it could be concluded that Giza 161 was the most liable to stem rust severity (51.8%, as an average of the two seasons), but Sakha 8 was the lowest one (13.2%) compared to the other cultivars. In addition, the highest value of stem rust severity at each date of sowing was recorded for Giza 161 cultivar.

The two-factor interaction (Table 3) indicates that the intermediate planting date (20 November) for all studied cultivars increased grain yield/ha compared to either earlier or later sowings over the two seasons (Knapp and Knapp, 1978). Rusts lesser damage (Knapp and Knapp, 1978) in addition to favourable condition during reproductive period (Schlehuber and Tucker, 1967) were reasons behind wheat-highest yield. The lower yields from the 5

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December planting may be explained as a result of increasing rust severity (Data in Table 3) and poorly developed root system (Knapp and Knapp, 1978; Incerti and O'leary, 1990 and Winter and Musick, 1993). Yields were arranged in a trend of Sakha 8 > Sakha 69 > Gemmiza 1, Giza 157 > Giza 161 at any of sowing dates. Such trend indicated that yield characteristic is a genotype-dependent, affecting with prevailing conditions during wheat growth.

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تأثير مواعيد الزراعة على مقاييس النمو- المحصول والإصابة بالأصداء لبعض أصناف القمح

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أجريت تجربة حقلية فى عامى 1997 ، 1998 وذلك لدراسة المظاهر المصاحبة لكل من الإصابة بالأصداء والنمو والمحصول ومكوناته لخمسة أصناف من القمح (جيزة 157 ، جيزة 161 ، جميزة 1، سخا 8 ، سخا 69) زرعت فى ثلاثة مواعيد (11/5 ، 11/20 ، 12/5) وقد تم قياس الصفات التالية0
شــدة الإصابة بصدأ الورقة وصدأ الساق – عدد السنابل/م^2 – طول السنبلة – عدد الحبوب / سنبلة – وزن المائة حبة ومحصول الحبوب (طن / هكتار) 0
وقد أظهرت النتائج وجود تأثير ات معنوية مصاحبة لميعاد الزراعة على كل الصفات المدروسة خلال الموسمين فيما عدا شدة الإصابة بصدأ الأوراق (عام 1997) وطول السنبلة و عدد الحبوب / السنبلة خلال موسمى الزراعة0
وقد أدت الزراعة المبكرة (11/5) إلى إنخفاض شدة الإصابة بالأصداء خلال موسمى الزراعة فى حين أدت الزراعة فى الميعاد الثانى (11/20) إلى الحصول على أعلى إنتاجية من الحبوب (46ر7 ، 60ر6 طن/هكتار فى عامى 1997 ، 1998 على الترتيب) وكذلك أعلى عدد سنابل /م^2 وأثقل الحبوب0
كذلك أوضحت النتائج أن هناك فروقا معنوية بين الأصناف الخمسة المختبرة فى كل الصفات المدروسة فى الموسمين ماعدا وزن المائة حبة0 حيث أظهر الصنف جيزة 161 أعلى إستجابة للإصابة بالأصداء والتى بلغت 52ر29% ، 82ر51% لكل من صدأ الورقة والساق على الترتيب مما أدى إلى إعطائه أقل محصول من الحبوب (47ر4 طن / هكتار) وعلى العكس فقد أظهر الصنف جميزة 1 أقل درجة من الإصابة بصدأ الأوراق ودرجة متوسطة من الإصابة بصدأ الساق (1ر5% ، 2ر19% كمتوسطين للموسمين) وأعطى أطول السنابل وأعلى عدد من الحبوب / سنبلة – كما تفوق الصنف سخا 8 على كل الأصناف فى صفة إنتاج الحبوب (29ر7 طن / هكتار) وعدد السنابل /م^2 (74ر408) كتوسط للموسمين0
وقد أوضحت النتائج معنوية التفاعل بين ميعاد الزراعة والأصناف لصفتى صــدأ الساق ومحصول الحبوب فى السنتين وصدأ الورقة فى الموسم الثانى فقط وكانت شـــدة إصابة الصنف جيزة 161 بمرض صــدأ الورقة والساق مرتفعة (33ر58% ، 54ر64%) وذلك لميعاد الزراعة الأخير على الترتيب – ومن ناحية أخرى أعطى الصنف سخا 8 أعلى إنتاجية من الحبوب للهكتار (93ر7 طن) وذلك عند الزراعة فى الميعاد الثانى (11/20)0

Table (1) : Mean squares of wheat characters in 1997/98 and 1998/99 seasons.

Source of variations	d.f.	Leaf rust severity		Stem rust severity		Number of spikes/m^2		Spike length (Cm)		Number of grains/spike		100-kernel weight(g)		Grain yield (t/ha.)	
		97 / 98	98 / 99	97 / 98	98 / 99	97 / 98	98 / 99	97 / 98	98 / 99	97 / 98	98 / 99	97/98	98/99	97/98	98/99
Sowing Dates (A)	2	258.85	1019.49**	4640.60**	606.67*	3354.21**	6615.03**	2.94	0.23	163.17	18.65	1.35**	0.59**	1.62**	2.64**
Error (a)	6	75.95	70.46	27.38	65.93	266.06	155.29	0.91	2.66	99.75	37.40	0.09	0.03	0.03	0.06
Varieties (B)	4	2165.11**	3472.58**	4229.46**	2808.92**	5241.68**	1716.36**	8.42**	3.80**	670.49**	664.15**	0.24	1.27	0.81**	1.77**
A X B	8	37.67	323.96**	265.43**	209.64*	272.84	162.69	1.75	1.42	39.12	35.42	0.09	0.04	1.24**	0.29**
Error (b)	36	80.14	45.90	49.45	55.38	117.43	91.58	0.87	0.63	18.61	29.38	0.11	0.95	0.03	0.05

***,** Significantly different at 0.05 and 0.01 probability levels, respectively.**

Table (2) : Means of wheat characters as affected by sowing dates and cultivars in 1997/ 98 and 1998/99 seasons.

Treatments	Leaf rust severity		Stem rust severity		Number of spikes/m^2		Spike length (Cm)		Number of grains/spike		100-kernel weight(g)		Grain yield (t/ha)	
	97 / 98	98/ 99	97 / 98	98 / 99	97/ 98	98/ 99	97/ 98	98/ 99	97/ 98	98 / 99	97/98	98/99	97/98	98/99
Sowing Dates														
5 / 11	10.15	6.12	18.65	17.07	376.50	353.33	9.59	8.95	53.91	49.57	4.64	4.32	7.05	5.94
20 / 11	14.40	7.46	24.55	16.40	419.11	421.10	10.10	9.20	48.38	48.65	4.71	4.52	7.46	6.60
5 / 12	15.53	22.22	42.55	27.73	332.83	291.10	9.41	8.91	52.40	49.54	4.24	4.12	6.12	4.67
L.S.D.$_{0.05}$	**N.S.**	**6.50**	**4.49**	**6.28**	**42.07**	**32.14**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**0.23**	**0.14**	**0.32**	**0.44**
Varieties														
Giza 157	17.00 S	14.44 S	34.67 S	13.33 S	332.20	340.37	10.11	9.65	46.12	45.47	4.37	3.95	5.99	5.77
Giza 161	36.16 S	22.88 S	52.75 S	50.89S	279.43	337.77	8.19	8.07	43.15	35.24	4.71	4.69	5.14	3.80
Gemmiza 1	3.58 M.S	6.61 M.S	20.08 S	18.33 M.R	391.10	355.53	10.20	10.03	62.33	56.45	4.62	4.69	7.52	6.19
Sakha 8	3.98 S	8.00 S	21.00 R	5.45 R	439.70	377.77	10.03	8.76	54.20	55.71	4.52	4.55	8.00	6.58
Sakha 69	6.08 S	7.75 S	14.42MR	14.00 S	438.33	364.43	9.96	8.60	52.00	53.37	4.42	3.80	7.75	6.33
L.S.D.$_{0.05}$	**7.42**	**5.62**	**5.83**	**6.17**	**29.93**	**26.44**	**0.77**	**0.66**	**3.58**	**4.49**	**N.S.**	**N.S.**	**0.32**	**0.45**

N. S.: Not significant. S. = Susceptible. M.S. = Moderately susceptible. M.R. = Moderately resistant. R. = Resistant.

Table (3): Sowing date X cultivar interaction for leaf rust severity (in 1998), stem rust severity and grain yield/ha (in the two seasons).

Treatments	Leaf rust severity			Stem rust severity						Grain yield (t / ha.)					
	1998/ 99			1997 / 98			1998 / 99			1997 / 98			1998 / 99		
	5 / 11	20 / 11	5 / 12	5 / 11	20 / 11	5 / 12	5 / 11	20 / 11	5 / 12	5 / 11	20 / 11	5 / 12	5 / 11	20 / 11	5 / 12
Giza 157	5.48	6.51	31.33	19.50	27.00	57.50	20.67	2.33	17.00	5.97	6.51	5.48	6.38	6.56	4.37
Giza 161	4.54	5.77	58.33	42.00	55.50	60.75	43.00	41.33	68.33	5.10	5.77	4.54	2.94	5.21	3.25
Gemmiza 1	6.80	7.93	5.10	15.75	16.75	27.75	16.67	14.00	24.33	7.82	7.93	6.80	6.62	6.92	5.04
Sakha 8	6.91	8.62	8.48	9.25	9.25	44.50	3.67	3.67	9.00	8.48	8.62	6.91	6.76	7.24	5.73
Sakha 69	6.89	8.49	7.86	6.75	14.25	22.25	1.33	20.67	20.00	7.86	8.49	6.89	6.99	7.05	4.96
$L.S.D._{0.05}$	9.73			10.09			10.68			0.55			0.78		