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Morphological and Anatomical Study on some Wheat Cultivars and Their Response to Seasonal Variations

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Abstract: An experiment was conducted at The Agricultural Experimental and Research Station, Faculty of Agriculture, Cairo University, Egypt during the two successive seasons of 2007/2008 and 2008/2009. Two wheat species were adopted to evaluate some morphological and anatomical features as well as some yield and yield attributes. Seasonal influences on performance of cultivated genotypes have been considered. Six cultivars, three of bread wheat (*Triticum aestivum*) viz., Sids1, Gemmieza7 and Sakha93&others of macaroni wheat (*Triticum durum*) viz., Beni Sweif1, Beni Sweif3 and Sohag3, were utilized. Regarding the bread wheat, plants of Sids1cv. were the tallest ones in both seasons. Plants of Sakha93 cv. was the superior with respect to number of leaves/plant in the first season and Gemmeiza7 in the second one. Wider leaf area/plant was for Sids1. The highest dry weight of shoot was produced by Gemmeiza7 plants in both seasons with significant differences compared to the other two cultivars. Regarding the durum wheat, insignificant differences were detected between the three studied cultivars with respect to plant height in both seasons and number of developed tillers/plant in the first season. Plants of Beni Sweif1 produced the highest shoot dry weight in the first season with significant difference. In the second season, maximum shoot dry weight/plant was recorded by Sohag3 plants with significant differences. Regarding seasonal effect, pronounced increase was achieved in shoot dry weight and weight of 1000 kernels in majority of the studied cultivars in the second season compared to the first one. Main spike length and number of spikelets /main spike were reduced as higher temperature was prevailed in the second season. As to the seasonal effect on performance of the two species, insignificant differences were detected between seasons except for seed index of the species *T. aestivum*. The trait was significantly increased by 27.4% in the second season over that in the first one. Considerable but insignificant increment was recorded in shoot dry weight of both species in the second season. The percentages of increment were 63.8% and 103.3% for *T. aestivum* and *T. durum* respectively. Means of number of grains/plant were reduced in the second season by 8.3% and 10% for *T. aestivum* and *T. durum* respectively. Weight of grain yield/plant was increased in the second season by (27.5%) and (3.4%) for *T. aestivum* and *T. durum* respectively. Comparing between the studied species, higher numbers of spikelet/spike were produced by *T. aestivum* cvs. compared to *T. durum* ones in both seasons, the latter possessed shorter spikes. Insignificant differences were detected between the two species except for number of grains/plant in both seasons and weight of grain yield/plant in the first season, *T. durum* was the superior. Seed index was increased by 21% in *T. durum* over that of *T. aestivum* in the first season while it reduced by 9.6% in the second one. No great differences were recognized comparing the anatomical features of main stems as well as flag leaves of the studied cultivars. Stem transection of Sids1 cv. exhibited narrower chlorenchyma adjacent to the peripheral bundles .Stem outlines of Beni Sweif 1 and Sohg 3 were slightly ridged as the peripheral bundles located. Stem bundles of Sohg3 cv. seemed to arrange in three concentric rings, the inner ring contains the larger vascular bundles. Peripheral larger bundles, occasionally found in stems of Gemmeiza7 and Sakha93, are separated from the epidermis by layers of sclerenchyma. In Gemmeiza7 stem, chlorenchyma adjacent to the outer peripheral bundles occasionally extended tangentially seemed in connection between the nearby bundles. Flag leaf of Sakha93 cv. obviously differed. It possessed thicker midrib, contains the largest vascular bundle, than the two sided lamina. The laminar bundles appeared in zigzag manner. Flag leaves of the other cultivars possessed midribs slightly thicker than the lamina.

Key words: Wheat, *T. aestivum, T. durum*, cultivars, morphology, anatomy, yield component and seasonal influences.

INTRODUCTION

Wheat is one of the first cultivated plants. It is a winter crop planted in temperate regions. It is considered as the most important cereal in terms of an energy supply for human. Macaroni wheat (*Triticum durum*) considered as a tetraploid wheat species cultivated to fulfill the demands of the pasta market. Whereas (*Triticum aestivum*) is one of the hexaploid wheats, widely grown throughout the planet (Serna–Saldivar, 2010). Thomas *et al.*

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(2006) pointed out that, large number of wheat varieties have been bred over years to sustain higher production levels. These varieties have been described primarily by morphological characteristics, which show stage and tissue specific expression and interaction with the environment. The author suggested relatively narrow genetic bases of the tetraploid varieties as compared to the hexaploids by using random amplification of polymorphic DNA (RAPD). Cluster and principal component analysis clearly distinguished the tetraploids from the hexaploids.

Klepper *et al.* (1982) estimated that wheat canopy development is a complex process as it involves a dynamic population of leaves on a changing population of tillers. The author added, total number of leaves on the main stem and leaves' appearance rate have been shown to be correlated with accumulated thermal units. In tropical environment, the productivity of wheat decreases as mean daily temperature rises above approximately 15ºC, in part because accelerated crop development rate reduces crop duration (Midmore *et al.*, 1982). Rahman (2004) estimated an adverse effect of heat on the whole life cycle of wheat plant including vegetative and reproductive periods. In parts of Africa, Asia and Central America yields of wheat and maize could decline by around 20 to 30 percent as temperature rises by 3 to 4ºC (Arthur, 1988). In Pakistan, Yousaf *et al.* (2008) evaluated seventy local and exotic bread wheat (*Triticum aestivum*) genotypes for eight metric traits i.e., plant height, number of productive tillers per plant, number of spikelet per spike, spike length, number of grains per spike, fertility %, seed index and yield per plant. The author reported significant genotypic differences for all studied traits indicating considerable amount of variation among genotypes for each character.

The present work was laid out to evaluate some morphological, anatomical and yield characteristics of some bread and durum wheat cultivars. Seasonal influences were also concerned.

MATERIALS AND METHODS

The current investigation was carried out at the Agricultural Experimental and Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt during two successive winter seasons 2007/2008 and 2008/2009. Three cultivars of bread wheat (*Triticum aestivum*) viz., Sids1, Gemmeiza7, and Sakha93 & others of durum wheat (*Triticum durum*) viz., Beni Sweif1, Beni Sweif 3 and Sohag3 were adopted. Grains were obtained from the Filed Crop Research Institute, Agricultural Research Center, Giza, Egypt. Grains were sown on November 20th in the first and second seasons. The layout of the experiment was split plot design replicated thrice. Grains were drilled in rows, 4m long and 20cm apart with seed rate 60kg/feddan. The normal cultural practices were carried out as recommended in the vicinity.

Vegetative growth characters were estimated at 3 sampling dates, 100, 115 and 130 days after sowing. They included plant height (cm), number of tillers and leaves/plant, total leaf area /plant (cm^2) and dry weight of shoot/plant (g). At harvest, main spike length (cm), number of spikelets/spike, number of grains/plant, weight of grain yield/plant and weight of 1000 grains (g) were estimated. The data was statistically analyzed using split plot design according to Snedecor and Cochran (1982). Means were compared by L.S.D. values at 5% level.

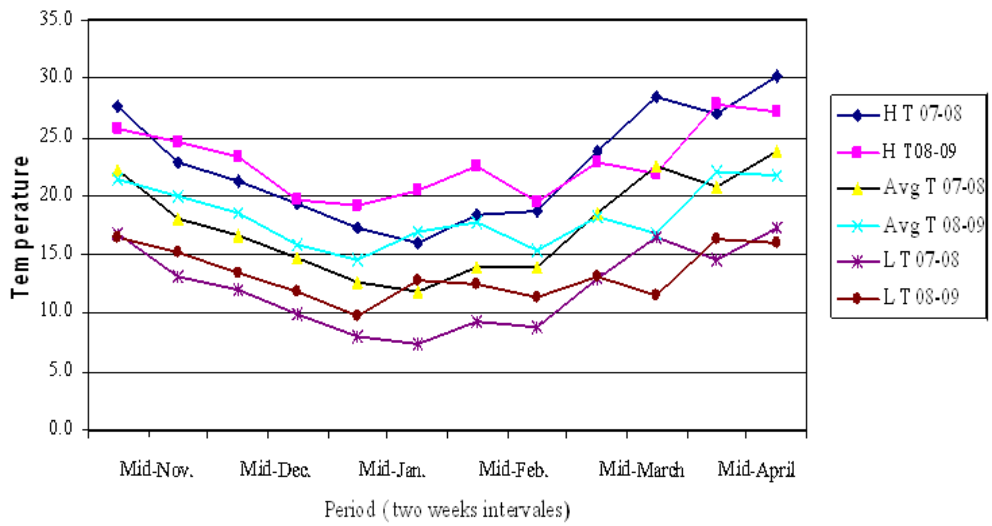


Fig. 1: Air temperatures during the growth period of wheat plants in 2007/2008 and 2008/2009 seasons.

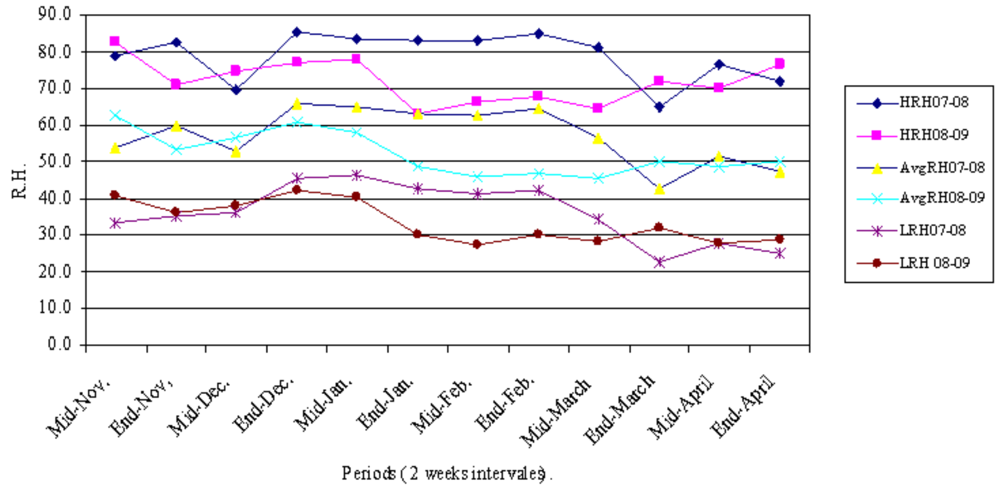


Fig. 2: Relative humidity during the growth period of wheat plant in 2007/2008 and 2008/2009 seasons.

Anatomical Study:

Specimens were taken from the flag leaf and the second internode beyond the main stem spike at the age of 100days in the second season. Specimens were killed and fixed at least 48 hrs. in FAA (10ml formalin, 5ml glacial acetic acid and 85ml ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax of melting point 56^{o}C. Sections were cut, 15 and 20 µ thick, in the flag leaf and determined internode respectively. Safranin- fast green combination method (Sass, 1961) was used for staining. Stained sections were cleared in xylene and mounted in Canada balsam (Willey, 1971). Sections were microscopically examined and photomicrographs were taken.

RESULTS AND DISCUSSION

Growth Characteristics:

Tables (1&2) represents some morphological traits of six wheat cultivars belonging to two species of *Triticum* at three stages of growth 100, 115 and 130 days after sowing in two growing seasons; 2007/2008 and 2008/2009.

Concerning the bread wheat, Table (1) shows that means of plant height were varied significantly comparing between the three cultivars of *T. aestivum* with each other in the first growing season. Differences were detected in all sampling ages. Plants of Sids1 cv.were the tallest ones in both seasons. Number of leaves/plant was also statistically differed especially at the last sampling age (130 days). Sakha93 cv. was the superior in the first season and Gemmeiza7 in the second one. This could be related to higher number of developed tillers. Wider leaf area/plant measured at the last sampling date was for Sids1 plants compared to Gemmeiza7 and Sakha93 cvs. plants. Meanwhile Sids1 recorded the lowest number of leaves/plant in both seasons.

The highest dry weight of shoots was produced by Gemmeiza 7 plants in both seasons. Moreover, the differences were mostly significant compared to the other two cultivars. Increments induced in dry weight of such cultivar could be interpreted by higher leaf area measured at the first stage of growth, till 100days after sowing (1152.2 and 772.7 cm^2 for the first and second seasons respectively). Also, higher number of leaves was produced at this stage of growth (26.0 and 43.7 for the first and second seasons respectively). This indicates highly assimilation rate occurrence, consequently dry matter production and accumulation could be expected for this cultivar. Increment induced in dry weight of shoot of Gemmeiza 7 plants could be attributed to heavier leaves and/or thicker stem walls possessed (Fig. 3:2A). Klepper *et al.* (1982) indicated that leaf area development during crop growth is dependent on the rate of leaf appearance and number of developed leaves. In comparison to all cultivars, maximum averages plant height was recorded for Sids1 cv. plants at all growth stages in both growing seasons. The shortest plants were recorded for Sakha93 cv. plants, with significant differences only in the first season.

Regarding the durum wheat, insignificant differences were detected between the three studied cultivars with respect to plant height in both seasons and number of developed tillers/plant in the first season at three sampling dates. The widest leaf area/plant (663.5cm^2) was produced by Beni Sweif1 cv. at the last date in the first season. This might be due to the highest number of leaves produced by this cultivar at this stage of growth (Klepper *et al.*, 1982). Moreover, plants of Beni Sweif1 produced the highest shoot dry weight with significant differences comparing with the other two cultivars. This could be interpreted by higher leaf area/plant (cm^2) produced by the plants at the first stage of growth i.e., till 100 days after sowing (1038.1cm^2). In the second growing season, Sohag3 plants performed better concerning the trait while producing the lowest leaves' number compared to the other two cultivars. Maximum shoot dry weight was recorded by the mentioned cultivar with significant differences. Also it was produced relatively higher leaf area/plant compared to all studied cultivars at all sampling dates.

Tables (1&2) illustrate the performance of the studied cultivars comparing between the two growing seasons 2007/2008 and 2008/2009. As to the cultivars of bread wheat (*T. aestivum*), Sids1 plants were apparently taller with reduced number of leaves and higher developed tillers in 2007/2008 compared to those grown in 2008/2009 season. Higher, moreover nearly doubled shoot dry weight was achieved by Sids1 plants in the second season (26.39). Increment induced in dry weight of such cultivar could be interpreted by increasing in the number of leaves/plant especially those counted in the last sampling date, 130 days (24.7). Consequently, leaf area/plant (635cm^2) measured at this age was increased. Shoot dry weight/plant recorded for Gemmeiza7 cv. was more or less doubled in plants being cultivated in the second growing season (44.9) compared to the first one (24.8). This result could be related to increment recorded for those plants in both number of tillers and leaves.

Higher shoot dry weight/plant was recorded for Sakha93 cv. plants grown in the second season. Meanwhile, those plants produced lower leaf area/plant. A reduction was induced also in both plant height and number of tillers/plant compared to the first season. Increment of shoot dry weight of Sakha cv. plants could be attributed to higher number of leaves/plant possessed in the second growing season.

Table 1: Morphological traits of three cultivars of bread wheat (*Triticum aestivum*) and others of durum wheat (*Triticum durum*) in the first growing season 2007/2008.

Characters		Plant height (cm)			Number of tillers/plant			Number of leaves/plant			Leaf area/plant (cm²)			Shoot dry weight (g/plant)		
Age (day) / Cultivars		100	115	130	100	115	130	100	115	130	100	115	130	100	115	130
T. aestivum	Sids1	126.3	131.0	136.6	3.5	4.5	5.3	22.3	20.3	11.5	937.6	816.2	620.4	15.0	23.5	15.8
	Gemmeiza7	110.0	114.0	117.3	3.5	4.0	5.0	26.0	22.7	14.5	1155.2	714.6	533.6	22.2	30.5	24.8
	Sakha93	91.0	96.0	103.6	6.0	6.5	7.3	24.3	22.6	19.0	595.5	607.5	468.4	17.6	27.3	23.4
T. durum	Beni sweif1	101.3	107.0	116.3	4.7	5.5	6.0	24.0	25.3	23.0	1038.1	843.0	663.5	12.6	21.7	17.8
	Beni sweif3	103.3	109.5	112.7	5.0	5.5	5.5	25.7	23.3	22.0	789.8	670.9	583.4	11.8	19.6	12.5
	Sohag3	100.3	103.5	109.3	4.0	5.3	5.5	22.0	20.0	16.5	911.7	833.4	624.0	14.0	22.3	14.1
L.S.D. (0.5%)		8.7	9.7	10.6	1.6	1.9	1.5	0.96	0.99	1.7	245.3	326.2	226.9	2.63	2.46	3.26

Table 2: Morphological traits of three cultivars of bread wheat (*Triticum aestivum*) and others of durum wheat (*Triticum durum*) in the second growing season 2008/2009.

Characters		Plant height (cm)			Number of tiller/plant			Number of leaves/plant			Leaf area/plant (cm²)			Shoot dry weight (g/plant)		
Age (day) / Cultivars		100	115	130	100	115	130	100	115	130	100	115	130	100	115	130
T. aestivum	Sids 1	100.7	106.6	115.3	3.7	4.0	4.0	45.3	36.6	24.7	604.9	735.6	635.8	62.4	65.3	26.3
	Gemmeiza7	105.0	107.0	110.0	5.5	6.0	6.3	43.7	39.7	37.7	772.7	696.3	611.3	61.9	63.7	44.9
	Sakha 93	83.0	92.3	99.3	5.0	5.0	5.0	39.5	37.6	31.0	520.8	575.7	425.3	63.3	66.8	33.4
T. durum	Beni Sweif 1	95.7	100.7	108.3	4.0	4.0	4.2	20.2	23.5	27.7	733.7	770.6	414.5	46.3	49.3	21.0
	Beni Sweif 3	100.0	105.0	108.0	5.0	5.7	5.8	29.3	26.0	22.3	622.6	727.9	572.2	43.3	50.7	26.8
	Sohag 3	102.3	102.7	103.7	5.7	6.7	7.0	27.2	25.3	18.7	744.1	749.4	727.3	68.7	69.8	43.1
L.S.D. (0.5%)		7.2	7.6	9.4	0.88	0.73	1.50	6.6	5.2	4.3	143.3	211.8	132.6	4.3	5.7	2.9

Regarding the durum wheat cultivars, plants of Beni Sweif1 cv. grown in the second season produced higher dry weight of shoot compared to the first one, especially at the ages of 100 and 115 days. Most of the studied traits were obviously reduced compared to the first growing season. The same observations were more or less detected with respect to mean of shoots dry weight of Beni Sweif3 cv. plants. But variable performance was recognized by most growth characters of Beni Sweif3 compared to those of Beni Sweif1 ones during the growing period of the second season. Dry weight of shoot of Sohag3 cv. plants was apparently higher in the second season. Moreover, it became about 3-4 times over that weighted in the first season, at all sampling dates. Increment achieved might be due to an increase in number of both tillers and leaves developed by plants of this cultivar.

Meteorological data in Figs. (1&2) exhibited lower averages air temperatures in the first growing season 2007/2008 compared to the second one, especially from mid-November to end February. Air temperature then increased till end March, fluctuated and being more or less the same in both seasons up to end April. Averages relative humidity values were fluctuated during the first period of wheat plant growth (till end December) in both seasons (Fig. 2). Variable relative humidity values were recorded comparing between the two growing seasons especially from end December to end March. The values measured for this period were apparently lower in 2008/2009 than those for 2007/2008 season. In other words, majority of the growing period in season 2008/2009 was characterized by warmer weather with reduced relative humidity compared to the first one. Hence, wheat plans underwent variable relative humidity and air temperatures prevalent during the majority of growth period in the two growing seasons.

It is worthy to notice from Tables (1&2) that, averages plant height apparently reduced in all studied cultivars in the second growing season. Tillering performance of all studied cultivars was varied comparing between the two seasons. Sids1, sakha93 and Beni Sweif1 were performed better in the first season and vice versa the others. Averages number of leaves/plant were enhanced in the second season by all studied cultivars compared to the first one. Increments were obviously noted in bread wheat cultivars. Variable performance was detected concerning leaf area/plant (cm^2). The trait was apparently reduced in each of Sids1, Gemmeiza7 and Sohag3 in the second season compared to the first one.

These results are more or less in accordance with the findings obtained by Rahman (2004) and Ahamed *et al.* (2010) who estimated the adverse effect of higher temperatures on wheat plant growth. Higher temperature was found to enhance leaf senescence causing reduction in green leaf area during reproductive stages (Wardlaw and Moncur, 1995).

It could be concluded therefore that, means of most growth characters varied in their response comparing the performance of the studied cultivars in both seasons. Pronounced increase was recognized in shoot dry weight /plant in the majority of studied cultivars in the second season compared to the first one. These observations could be interpreted by variable seasonal influences on wheat plants due to variable temperature and relative humidity values prevalent in the two growing seasons.

Yield and Yield Components:

Tables (3&4) represent some reproductive and yield characteristics of six wheat genotypes in two successive seasons. Main spike length of cultivars those belonging to *T. durum* seemed to be shorter than those of *T. asetivum* in both seasons with significant differences. Maximum main spike length was recorded by Gemmeiza7 cv. (13.5 and 13.35 in the first and second seasons, respectively) without significant differences between *T. aestivum* cultivars. Sohag 3 plants are with the longest main spike compared to the other durum cultivars without significant difference. The shortest main spike length was recorded for Beni Sweif1 cv. plants in both seasons (Tables 3&4).

Maximum number of Spikelets of *T. aestivum* species was born on Gemmeiza 7 cv. spike, 21.53 and 19.55 for first and second seasons, respectively. Significant differences were detected between the number of spikelets of Gemmeiza7 cv. and the other *T. aestivum* ones, Sids1 and Sakha93 especially in the second season (Table 4). The highest number of spikelets/spike of the durum species was for Beni Sweif3 (20.13 and 19.71 for the first and second seasons, respectively) with significant differences compared to the other two cultivars. Higher numbers of spikelet/spike were produced by *T. aestivum* cvs. compared to *T. durum* ones Meanwhile, the latter possessed shorter spikes in both seasons.

Main spike length and spikelets, number/main spike were reduced in majority of the studied cultivars in the second season compared to the first one, as higher temperature was prevailed. Ahamed et al. (2010) pointed out reduction in each of ear length and number of spikelets/main stem as bread wheat plants subjected to heat stress. Contradicting, majority of the studied cultivars exhibited an increase in 1000 grain weight in the second season. This is in disagreement with the findings of Ahamed *et al*. (2010) as an effect of high temperature.

Table 3: Some reproductive and yield characteristics of three cultivars of bread wheat (*T. aestivum*) and others of durum wheat (*T. durum*) in the first growing season 2007/2008.

Characters / Cultivars		Main spike length (cm)	Number of spikelets/spike	Number of grains/plant	Weight of grain yield (g/plant)	Weight of 1000 grains (g)
T. aestivum	Sids1	11.93	20.26	238.66	9.53	39.87
	Gemmeiza7	13.50	21.53	250.30	7.32	34.90
	Sakha93	11.70	19.46	168.66	7.27	43.20
T. durum	Beni Sweif1	7.40	18.40	230.00	12.07	52.50
	Beni Sweif3	7.57	20.13	296.40	9.70	39.20
	Sohag3	8.17	19.66	350.84	12.80	51.16
L.S.D. (0.5%)		1.6	1.2	33.6	3.3	5.2

Table 4: Some reproductive and yield characteristics of three cultivars of bread wheat (*T. aestivum*) and others of durum wheat (*T. durum*) in the second growing season 2008/2009.

Characters / Cultivars		Main spike length (cm)	Number of spikelets/spike	Number of grains/plant	Weight of Grain yield (g/plant)	Weight of 1000 grains (g)
T. aestivum	Sids1	11.42	19.20	216.46	10.0	46.20
	Gemmeiza7	13.35	19.55	231.63	12.5	53.96
	Sakha93	11.57	17.30	159.18	8.0	50.25
T. durum	Beni Sweif1	7.20	15.50	209.37	11.5	54.92
	Beni Sweif3	7.75	19.71	265.38	10.6	39.94
	Sohag3	8.31	16.20	322.53	13.75	42.36
L.S.D. (0.5%)		2.1	1.7	30.3	3.4	4.6

The cultivar Sohag3 developed the highest number and weight of grains/plant in the second season, meanwhile it produced lower seed index compared to most of the studied cultivars with mostly significant differences.

Though Gemmeiza7 cv. produced the highest shoots dry weight (24.89) in the first season, it recorded the lowest seed index (34.90g) compared to all studied cultivars with significant differences. In the second season, it was among the highest seed index cultivars (53.96g) and it ranked the second. It is worthy to mention that, the cultivar Gemmeiza7 was the superior concerning dry weight of shoot/plant at 130 days (44.90g). Thus it performed better in the second season compared to the first one. The cultivar Sakha93 apparently performed better in the second season compared to the first one concerning seed index, 50.25 and 43.20g in the second and the first seasons respectively. It ranked the 3rd in both seasons.

Regarding the durum wheat cultivars, heavier grains/plant was produced by Beni Sweif1 cv. which exhibited higher leaf area/plant especially at the age of 100 days in both seasons. It produced the highest seed index in both seasons compared to the other durum wheat cultivars or those of bread wheat ones. Meanwhile it produced an intermediate and the lowest weight of shoot/plant in the first and second seasons, respectively. Klepper *et al.* (1982) pointed out that the grain yield is dependent on the number of leaves and leaf area possessed. The lowest weight of 1000 grains recorded in the second season was for Beni Sweif3. It was located among the lowest seed index cultivars in both seasons. The differences were mostly significant compared to the other cultivars. The cultivar Sohag3 performed better in the first season concerning weight of 1000 grains. It ranked the 2nd and the 5th in the first and second seasons respectively compared to the other studied cultivars, while it was highly dry weight producer in the second season.

Comparing between the two seasons, variable responses were detected concerning yield attributes in majority of the studied cultivars (Tables 3&4). Higher numbers of kernels/plant were counted for all studied cultivars in the first season. Weight of grain yield (g/plant) performed better in the second season. Except for Sohag3 cv, seed index was apparently increased in the second season compared to the first one.

Table (5) shows mean performance of shoot dry weight, 130 days after sowing, and grain yield/plant of bread wheat (*T. aestivum*) and durum wheat (*T. durum*) in two growing seasons 2007/2008 and 2008/2009. Concerning the seasonal effect, insignificant differences were detected except for seed index of the species aestivum. The trait was significantly increased by 27.4% in the second season over that in the first one. Meanwhile, seed index was reduced by 4.1% in the species durum. Considerable but insignificant increment was recorded in shoot dry weight of both species in the second season. The percentages of increment were 63.8% and 103.3% for *T. aestivum* and *T. durum* respectively. Means of number grains/plant were reduced in the second season compared to the first one. The percentages of reduction were 8.3% and 10% for *T. aestivum* and *T. durum* respectively. Weight of grain yield/plant was increased in the second season. Increment percentage recorded for *T. aestivum* was higher (27.5%) than that recorded for *T. durum* (3.4%).

Comparing between the studied species, data in Table (5) exhibit insignificant differences except for the number of grains/plant in both seasons and weight of grain yield/plant in the first season, *T. durum* was the superior. While producing lower shoot dry weight/plant, durum species was possessed higher number of grains weighted higher yield/plant in both seasons. Weight of 1000 grains (g) was increased by 21% in *T. durum* over that of *T. aestivum* in the first season while it reduced by 9.6% in the second one.

Table 5: Mean performance of shoot dry weight and grain yield/plant of bread wheat (*T. aestivum*) and durum wheat (*T. durum*) in 2007/2008and 2008/2009 seasons.

Character / Species	Shoot dry weight (g/plant)		No. of grains/plant		Weight of grain yield (g /plant)		Weight of 1000 grains (g)	
	First	Second	First	Second	First	Second	First	Second
T. aestivum	21.3 a	34.9 a	219.2 b	202.4 b	8.0 b	10.2 a	39.3 a	50.1 a*
T. durum	14.9 a	30.3 a	292.4 a	265.8 a	11.5 a	11.9 a	47.6 a	45.7 a

Means followed by the same letters are not statistically different. *indicates significant mean square due to seasons.

It could be concluded therefore that, the performance of the studied cultivars varied comparing between the two growing seasons. Enhancement achieved in the second season by majority of the studied cultivars in each of dry weight of shoot/plant and weight of 1000 kernels might be attributed to efficient translocation and accumulation of assimilates. This may be due to variable climatic conditions prevalent in the second growing season compared to the first one. In other words, variable genotypic performances were exhibited by the studied cultivars, moreover species, in most of growth and yield characteristics. As they subjected to variable climate during the majority of growth period in both seasons.

In this connection, Midmore *et al.* (1982) estimated that the common wheat cultivars had variable performance under warm conditions. In central Mexico, Reynolds *et al.* (1999) pointed out clear differences in net photosynthetic rate among 16 bread wheat cultivars grown in a warm and low relative humidity environment .The author added that the differences were consistent across time of measurements, phenological stage and environment and revealed significant association with field performance.

Anatomical Study:

Transections were made in flag leaf as well as in the second internode beyond the main stem spike i.e., the second upper internode of the main stem at the age of 100 days after sowing. Three cultivars of bread wheat viz., Sids1,Gemmeiza7 and Sakha93 and two of durum wheat ones viz., Beni Sweif 1and Sohag3 were adopted for anatomical study.

The Stem:

Main stem cross section (Figs. 3&4A) exhibites circular, slightly ridged- outline with uniseriate lignified epidermal cells. Epidermal layer is underlaid by layers of sclerenchyma. Two concentric rings of vascular bundles were observed. The outer peripheral bundles are embedded completely in sclerenchyma beneath the epidermal layer. Few layers of dense chlorenchyma cells were noticed at both radial sides of each small peripheral bundle. Mostly, appeared as a wing-like shape in transection. The innermost larger vascular bundles are surrounded by the fundamental tissue of parenchyma encloses triangular intercellular spaces. Layers of parenchyma enlarged centripetally separate them from the pith cavity.

The vascular bundles are closed collateral type; each with phloem tissue located outwardly and consists of sieve elements and companion cells. Phloem abuts two large metaxylem vessels. Endarch protoxylem, 2-3 vessels arranged radially in one row, is located opposite to the phloem position. A cavity of collapsed protoxylem vessel was occasionally observed. Caps of sclerenchyma cells are noticed adjacent outwardly to the large inner stem bundles. The latter is encircled by incomplete lignified celled-sheath.

No great differences were recognized comparing the anatomical features of main stems of wheat cultivars under study. In comparison to the other cultivars, stem transection of Sids1 cv. exhibited narrower chlorenchyma adjacent to the peripheral bundles (Fig. 3:1A). Stem outlines of Beni Sweif 1 and Sohg3 were slightly ridged as the peripheral bundles located (Fig. 4A). The bundles of the latter cv. seemed to arrange in three concentric rings, and the inner ring contains the larger vascular bundles. Peripheral larger bundles occasionally found in stems of Gemmeiza 7 and Sakha 93, seemed apart from the epidermis by layers of sclerenchyma (Figs. 3:2 and 3A).

In Gemmeiza7 stem, chlorenchyma adjacent to the outer peripheral bundles occasionally extended tangentially and seemed to be in connection between the nearby bundles (Fig. 3:2A). Stem anatomy described is more or less in accordance with that detailed for most wheats by Hayward (1938). He estimated that the culm is hollow in the internodal region and solid at the constricted nodes. He mentioned that the hypodermal mechanical tissue is made up of fibrous cells forming a continuous zone of variable thickness; and this encloses the longitudinal bands of chlorenchyma, as well as smaller peripheral bundles.

Chapman and Peat (1992) stated that mature grass stem is with longitudinal vascular bundles embedded in parenchymatous ground tissue. The author added that grass species with hollow stems, the vascular bundles are arranged in one or more concentric rings. Also, column of strengthening sclerenchyma develop in close proximity to the vascular bundles.

The Flag Leaf:

Transactions made in flag leaf at the age of 100 days after sowing (Figs. 3&4B) exhibited that the upper (adaxial) epidermal layer consists of uniseriate somewhat rounded cells located above the bundles' positions. These are intercepted by few numbers of enlarged bulliform cells located in areas of lamina free from the vascular bundles i.e., areas contains mesophyll. Stomata were noticed besides groups of the bulliform cells overlie elongated chlorenchyma cells beneath the epidermal layer. The lower (abaxial) epidermis contains uniseriate small epidermal cells with fewer stomata. Mesophyll characterized by elongated chlorenchyma cells abuts the upper as well as the lower epidermis. Groups of such elongated chlorenchywa are arranged as one layer around the vascular bundles in a radial manner and following the bundle sheath. The remainder portion of flag leaf transaction was occupied by spongy tissue with varying sizes of chlorenchyma cells and closed vascular bundles. Vascular bundles, either the main bundle (midvein) or the lateral ones (laminar bundles) are surrounded by two–layered sheath. The inner layer consists of thick-walled cells and the outer one with thin–walled parenchyma arranged radially. Regardless of the main vascular bundle, the lamina contains large vascular bundles alternates with 1-4 smaller ones and all appear in strait manner along the lamina transection. The main and larger lateral bundles contain two large metaxylem vessels. Only one protoxylem vessel was observed opposite to the phloem position i.e., towards the adxial leaf side. Phloem composed of sieve tubes and companions cells. Few numbers of conducting elements were observed in the smaller lateral bundles. Vascular bundles were mostly joint to either both or one epidermis by bands of sclerenchyma cells.

Observations recorded for flag leaf transections were more or less in accordance with the findings of Hayward (1938) & Chapman and Peat (1992) on foliage leaf of wheats and grasses respectively. Hayward (1938) estimated that curling or expanding of the blade along its longitudinal axis is controlled by the bulliform or motor cells on the adaxial wheat leaf surface.

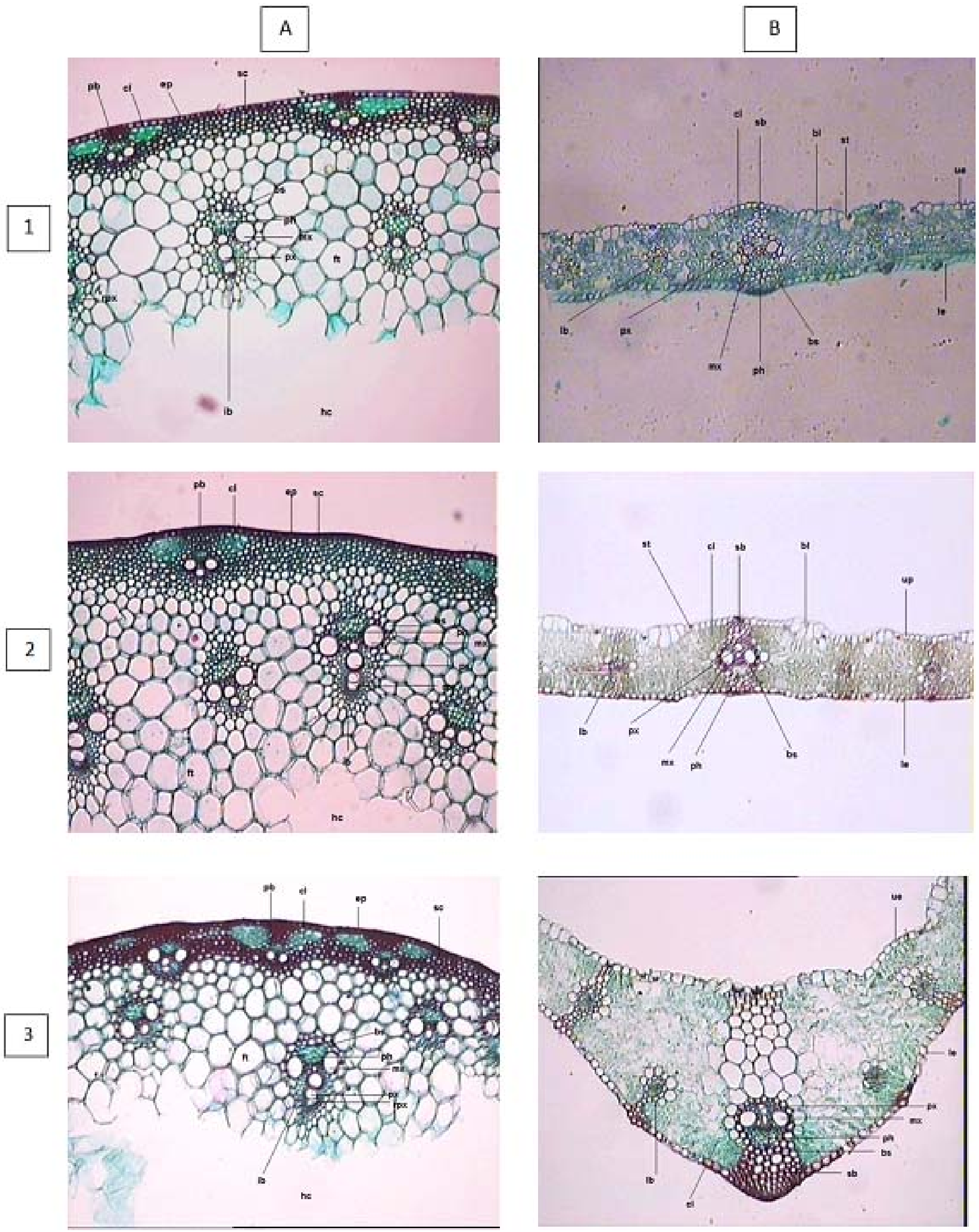
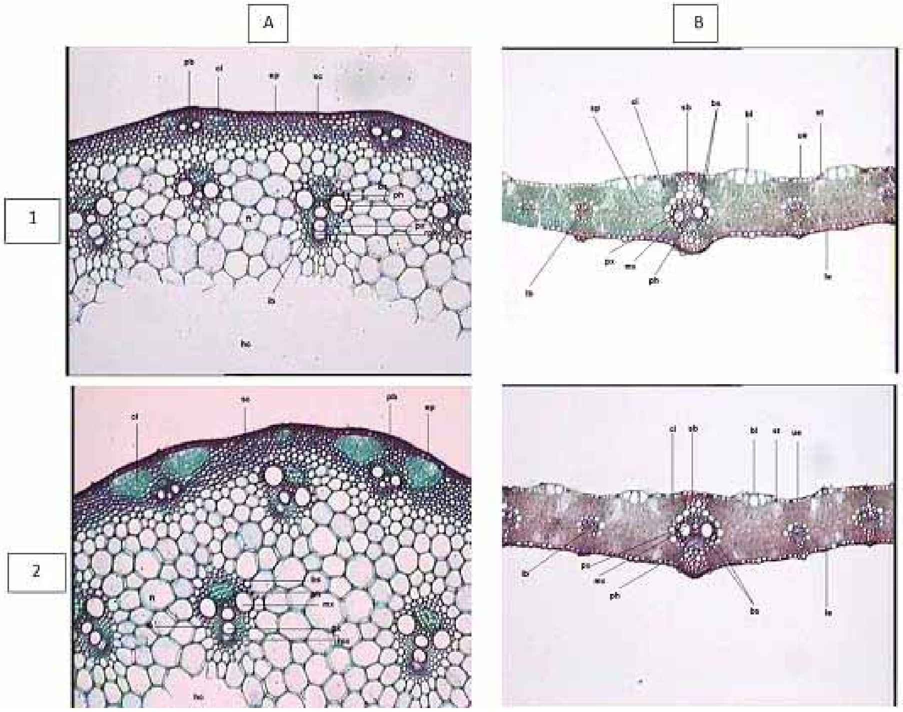


Fig. 3: Transections of main stem(A) and flag leaf (B) at the age of 100 days of bread wheat cultivars: 1-Sids1; 2- Gemmeiza7; 3- Sakha93.



(ep:epidermis; ue:upper epidermis; le: lower epidermis; st:stomata; bl:bulliform cells; cl:chlorenchyma sc:sclerenchy; sb: sclerenchyma band; bs:bundle sheath; ft: fundamental tissue; rpx:ruptured primary xylem; ph:phloem; mx:metaxylem; px: primary xylem; pb:peripheral bundle; ho:hollow cavity; ib: inner bundle).

Fig. 4: Transections of main stem (A) and flag leaf (B) of durum wheat cultivars at the age of 100 days: 1-Beni Sweif1; 2- Sohag3.

Regarding flag leaf, no great differences were observed in anatomical features between the studied cultivars. Transection made in flag leaf of Sakha 93 cv. exhibited that the midrib is apparently thicker, contains the largest vascular bundle, than the two sided lamina. Moreover, the laminar bundles appeared in zigzag manner (Figs. 3: 2B). Flag leaves of the other cultivars possessed midribs slightly thicker than the lamina. No great differences were detected between the structure of midvein bundle and the larger laminar ones.

In grasses, Chapman and Peat (1992) pointed out that the vascular bundle of foliage leaf may entirely surrounded by a variously specialized bundle sheath, which is of major significance in the photosynthetic specialization in leaves. The author revealed the presence of strengthening columns of sclerenchyma cells often found close to, and sometimes connecting with the larger bundles in leaves and stems. The author added that the grass leaf vascular bundles are with varying sizes, the central is the largest particularly in species with a well-defined midrib. A series of alternating larger and smaller bundles was found on either side of the central main bundle.

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