Agric. Res. J.; Suez Canal University; 2005

Identification of Some *Triticum* Species by the Inflorescence Features

A. E. Hassan, M. M. Sakr, A-G. I. O. Baz, and S. M. H. Gowayed
Dept. of Agric. Botany, Faculty of Agriculture, Suez Canal Univ. Ismailia, Egypt.

ABSTRACT

Eight Triticum species were obtained from different sources (six species imported from CIMMTY, Mexico, one species from ICARDA, Syria and one species from NSGC, USDA-ARS Aberdeen USA). The grains of different Triticum species were sown under the same conditions in the Experimental Farm of the Faculty of Agriculture, Suez Canal University, Ismailia Governorate on November 2003 season for studying the inflorescence morphology. The following results were obtained:-

Morphological characters of spike, rachis, spikelet (glume, lemma, palea), pollen grains and grains were varied among species.

Absent of rachis hairs was characteristic of T.spelta, T.monococcum and T.paleocolchicum and present in other species. Arrangement of basal internode of inflorescence in relation to the neck internode was oblique in T. paleocolchicum; whereas, it was vertical in the other species. Separation of spikelets with axial parts at the maturity stage was observed in T.dicoccoides compared with the other studied species. Furthermore, presence of sheath on basal internode of the neck region was recorded in T.paleocolchicum,; whereas, it was absent in the other species. Moreover, membranous spikelet glumes texture, linear shape of glumes and maximum glume length were characteristic for T.polonicum; absent glume keel was observed in T.dicoccoides compared with the other species. Furthermore, present of lemma horne was recorded in both T.aestivum and T.monococcum and absent in the other species. Palea splitting at maturity stage was observed in T.monococcum only compared with the other species. Moreover, the pollen grain shape was ovate in T.timopheevii, rear-shaped in T.dicoccoides and spherical in the other species. Presence of operculum on pore was observed in both T.aestivum and T.spelta.
In addition, the all studied parameters among Triticum species differed according to the studied species.

INTRODUCTION

The genus *Triticum* (20 species) known as wheat belongs to the family Poaceae, the subfamily Festucoideae, the tribe Triticeae (Jones and Luchsinges, 1987).

Wheat, in cultivated area and production output, is the largest single food crop on earth. None, other occupies as much arable land surface as does wheat it is used directly for human food, in bread making, for pasta and for producing alcoholic beverages.

As regard to spike inflorescence, Mandaville (1990) observed that the spike of *Triticum aestivum* was 5-12 cm long, 1-1.5 cm width (excluding awns , if present). Spikelets inserted alternating in steps on a flattened, ciliate-margined rachis; approximate to subimbricate, dense, oblong and 1-2 cm long. Glumes slightly shorter than the lemma, keeled off center and toothed or awned toward one side at the apex. Lemmas awnless (in beardless varieties) or with an awn to 7 cm long. Also, Elings (1991) observed that the awn and spike length, awn and spike colour and spikelets number per spike were varied between *Triticum* species. In addition, Watson and Dallwitiz (1992) and Slafer and Miralles (1993) observed that rachis of *Triticum* was hollowed, spikelet bearing axes with substantial rachis, it was solitary not second distichous, sessile 9-16 mm long, compressed laterally, disarticulating above the glumes, or falling with the glumes, not disarticulating between the floret. Glumes were two, more or less equal, shorter than the adjacent lemmas, or long relative to the adjacent lemmas, lateral to the rachis, without conspicuous tufts or rows of hairs, not pointed (obtuse, truncate or bidentate via the lateral nerves), not subulate and awned (or mucronate) or awnless. Lemma hairy, or hairless, non-carinate, or carinate. Palea present, relatively long, entire, or apically notched, 2-nerved, 2-keeled and their keels somewhat winged. Anther 2-4.5 mm long, not penicillate. However, Slafer and Miralles (1993) studied the number of fertile florest and grains per spike and individual grain weight varied among the three cultivars of bread wheat Belay *et. al.*. (1997) studied the patterns of morphological diversity in thirty- four tetraploid wheat (*T.turgidum*) and found that the glume pubescence, beak awn and spike density varied according to attitude and morph-agronomic traits. Furthermore, Szwed-Urbas *et al.* (2002) studied the differentiation of biometric features in the *T.durum* collection in 1996-2000 experiments were conducted on 230 genotypes of spring durum wheat. The following characteristics have been taken into consideration the length of spike rachis, number of spikelets and spike, weight of grain per spike and weight of 1000 grains.

As to the pollen grains, Erdetman (1966) and Dahlgren and Clifford (1982) noticed that the pollen

grains in the monocotyledon families had a single colpus-like aperture, a sulcus at distal pole as conceived from the center of the original tetrad. Also, they observed that the pollen grains in *T.aestivum* were monopore, operculate, surrounded by well-defined annular thickening. Moreover, Davis and Heywood (1991) and Moore *et al.* (1991) showed that the monocolpate of the pollen grains were provided with a single furrow which develops on one side of the grain remote from the point of contact in the tetrad, this is characteristic of monocotyledon families. Also, they reported that the pollen grains shape was useful in identification, thus pollen grains were described by the shape of their outline in polar and equatorial views.

Concerning the grains, Townsend and Guest (1968), Zohary (1972) and Lersten (1987) found that the grain was free between lemma and palea or adherent, oblong, elliptic and obovate shaped, hairy at the apex and deeply grooved adaxillary embryo about 1/5 length of caryopsis. Belay *et al.* (1997) studied that thirty-four tetraploid wheat (*T.dicoccoides*) landrace populations and noted that the grain colour, shape and length were varied according to the *T.dicoccoides* cultivars and geographical distribution.

The present research was performed to study the inflorescence characters of *Triticum* species and their application in identification of some *Triticum* species.

MATERIALS AND METHODS

Authentic grain samples of studied *Triticum* species were obtained from different sources as follows:-

Triticum aestivum L. from ICARDA (International Center for Agriculture Research in the Dry Areas) Syria; *T.spelta* L., *T.monococcum* L., *T.timopheevii* Zbuk., *T.diciccoides* Korn. Ex Asch. & Graebn., *T.durum* Desf. And *T.polonicum* L. from Center International de Mejoraminento de Maiz Y Trigo, int. (CIMMYT) Mexico; *T.paleocolchicum* (L.) Menabde from National small Grains Collection (NSGC) USDA-ARS Aberdeen USA. The grains of different *Triticum* species were sown under the same conditions in the Experemental Farm of the Faculty of Agriculture, Suez Canal University, Ismailia Governorate on November 2003 season. The plant samples were collected to study the following characters:-

1- Spike:

Awn length (cm), spike length (cm), number of spikelets/spike and spike weight (gm).

2- Rachis:-

Degree of axil erection, presence of hairs, axial internodes homogeneity, average internode length (mm, arrangement of basal internode of inflorescence in relation to the neck internode, arrangement of spikelets on the rachis, spikelets intensity, separation of spikelets with axial parts at the maturity stage, presence of furrows on basal internode of the neck region and presence of sheath on basal internode of the neck region.

3- Spikelet:-

a- Lower glume:

Glume texture, glume position in relation to the other flower parts, presence of keel, keel length, glume shape in outline, glume apex, presence of hairs on glumes, average maximum length of glume (mm) and average maximum width of glume (mm).

b- Lemma:

Lemma shape in outline, lemma apex, presence of horn, average maximum length (mm) and average maximum width (mm).

c- Palea:

Palea shape in outline, palea apex, palea splitting at maturity stage, average maximum length (mm) and average maximum width (mm).

d- Anther:

Average maximum length (mm), average maximum width (mm) and average horn length (mm).

e-Spermoderm pattern of the pollen grains:-

Pollen grains fixed in 2.5 % glutaraldehyde for 24 h. at 4 °C post-fixed in 1% osmium tetroxide for 1 h. at room temperature (Harley and Fergusen 1990) the specimens of studied taxa were dehydrated with ascending concentration of acetone till dried critical point and finally sputter coated with gold. The examination, measurements and photographing were done through Jeol Scanning Electron Microscope (JSM-T 330A) equipped with image recording and processing system (Semafore). The obtained data were pollen grain shape, pollen grain diameter (µm, pollen grain area (μm^2), diameter of ectoaperature pore (µm), diameter of endoaperature (µm), thickness of pore wall (µm) and presence of operculum on pore.

f- Grains:

Number of grains/ spike, number of grains/ spikelet, weight of grains/ spike (gm), 100 grains weight (gm), grain length (cm), grain width (cm), grains separable from lemma and palea on threshing, embryo shape in outline, embryo maximum length (mm) and embryo maximum width (mm).

RESULTS AND DISCUSSION

1-Spike:-

Data in Table (1) and Figure (1) reveal the morphological characters of spike existing in eight *Triticum* species. It is seen that there are significant

differences of the awn length, spike length, number of spickelets per spike and spike weight. The highest values of awn length (14.07 cm), spike length (20.47 cm), number of spikelets per spike (36) and spike weight (4.20gm)were noticed in *T.dicoccoides*, *T.spelta*, *T.durum* and *T.durum* (Fig. 1e, b, f and f, respectively). Whereas, the lowest ones of both awn length (4.07 cm) and spike length (6.52 cm) were recorded in *T.paleocolchicum* (Fig. 1g); also, the lowest values of number of spikelet per spik (13) and spike weight (0.89 gm) were observed in *T.dicoccoides* and *T.monococcum* (Fig.1 e and c, respectively).

2-Rachis:-

Data in Table (1) and Figures (2,3 and4) show that degree of axial erection was medium in *T.aestivum*, *T.timopheevii*, T.diciccides and *T.durum* (Fig.2a,d,e and f), low conspicuously in *T.spelta* (Fig.2b) and very conspicuous in *T.monococcum*, *T.paleocolchicum* and *T.polonicum* (Fig.2c, g and h). In addition, hairs were present in *T.aestivum*, *T.timopheevii*, T.dicoccoids, *T.durum* and *T.polonicum* (Fig.4a, d, e, f and h); whereas, they were absent in the other studied species (Fig. 4b, c and g). Axial internodes were heterogeneous being observed in both *T.spelta* and *T.paleocolchicum* (Fig.2b and g); while, they were homogeneous in the remaining studied species (Fig.2a, c, d, e, f and g). Moreover, the highest value of internode length (8.6 mm) was noticed in *T.spelta* (Fig.2b); whereas, the minimal value (3.4 mm) was observed in *T.monococcum* (Fig. 2c). Arrangement of basal internode of inflorescence in relation to the neck internode was oblique in *T.paleocolchicum* (Fig.3g); whereas, it was vertical in the other studied species (Fig. 3a, b, c, d, e, f and h). However, arrangement of spikelets on the rachis was whorled in *T.aestivum*, *T.timopheevii*, *T.dicoccoides*, *T.durum* and *T.polonicum* (Fig.1a, d, e, f and h); but it was in two opposite rows in the other species under study (Fig. 1b, c and g). On the other hand, spikelets intensity was lower in dense in *T.spelta* (Fig.1b), very dense in both *T.monococcum* and *T.paleocolchicum* (Fig.1c and g) and intermediate in other studied species (Fig.1a, d, e, f and h). Separation of spikelets with axial parts at the maturity stage was observed in *T.dicoccoides* only compared with the other species. Furthermore, presence of furrows on basal internode of the neck region was very conspicuous in *T.aestivum* (Fig.2a), absent in *T.spelta* (Fig.2b) and less conspicuous in the other species (Fig.2c-h). Presence of sheath on basal internode of the neck region was observed in *T.paleocolchicum* (Fig.3g); whereas, it was absent in the other species (Fig.3a, b, c, d, e, f and h). These results are in agreement with those obtained by Townsend and Guest (1968), Zohary (1972), Lersten (1987), Watson and Dallwitiz (1992), Miller *et al.* (1999) and Szwed-Urbas *et al.* (2002) who reported that inflorescence characters of *Triticum* genus are very important in recognition of *Triticum* species.

3-Spikelet:-

a-Glumes:-

Results in Table (2) and Figures (5 and 6) show that glume texture was membranous in *T.polonicum* (Fig.5h) and skinny in the other studied *Triticum* species (Fig.5a-g). In addition, glumes were long in relation to the other flower parts in *T.polonicum* (Fig.6h); whereas, they were short in the remainig studied species (Fig.6a-g). Keel absent was observed in *T.dicoccoides* (Fig.5e); but, it was present in the other species (Fig.5a,b,c,d,f,g and h). Keel was long in *T.aestivum* (Fig.5a), absent in *T.dicoccoides* (Fig.5e) and short in the other species (Fig.5b,c,d,f,g and h). Glume shape was oblong in both *T.aestivum* and *T.spelta* (Fig.5a and b), curved-linear in both *T.monococcum* and *T.paleocolchicum* (Fig. 5c and g), narrow ovate in both *T.timopheevii* and *T.durum* (Fig.5d and f), elliptic in *T.dicoccoides* (Fig.5e) and linear in *T.polonicum* (Fig.5h).Glume apex was truncate in *T.aestivum* (Fig.5a), obtuse in *T.spelta*, *T.paleocolchicum* and *T.polonicum* (Fig. 5b, g and h), emarginate in *T.monococcum* (Fig.5c), acuminate in both *T.timopheevii* and *T.durum* (Fig.5d and f) and acute in *T.dicoccoides* (Fig.5e). In addition, presence of hairs on glume surface was observed in both *T.timopheevii* and *T.dicoccoids* (Fig.5d and e); whereas, they were absent in other species (Fig.5a,b,c,f,g and h). Furthermore, the maximum values of glume length (28mm) and glume width (4.5mm) were recorded in *T.polonicum* and *T.aestivum* (Fig.5h and a), respectively; while, the lowest ones of both glume length (8mm) and width (2.0mm) were observed in *T.monococcum* (Fig.5c). These results are in harmony with those obtained by Townsend and Guest (1968), Lersten (1987), Mandaville (1990) and Slafer and Miralles (1993) who observed that glumes are subequal, shorter than the spikelet or longer (*T.polonicum*), more or less keeled, membranous or skinny.

b- Lemma:-

It is noticed from Table (3) and Figure (7) that lemma shape was oblong in *T.aestivum*, *T.monococcum* and *T.dicoccoides* (Fig.7a,c and e), narrow ovate in both *T.spelta* and *T.durum* (Fig.7b and f), linear in both *T.timopheevii* and *T.polonicum* (Fig.7d and h) and ovate in *T.paleocolchicum* (Fig.7g). In addition, lemma apex was obtuse in *T.aestivum*, *T.monococcum* and *T.polonicum* (Fig.7a,c and h), ovate in *T.spelta*, *T.timopheevii* and *T.paleocolchicum* (Fig.7b,d and g) and truncate in *T.dicoccoides* (Fig.7e). moreover, presence of horn in lemma was shown in both *T.aestivum* and *T.monococcum* (Fig.7a and c) and it was absent in other

Table (1): Morphological characters of spike and rachis of eight *Triticum* species

	Species / Recorded data	*Triticum aestivum*	*Triticum spelta*	*Triticum monococcum*	*Triticum timopheevii*	*Triticum dicoccoides*	*Triticum durum*	*Triticum paleocolchicum*	*Triticum polonicum*
Spike	Awn length (cm)	6.40	5.17	6.83	13.67	14.07	8.33	4.07	9.33
	Spike length cm)	8.47	20.47	6.53	12.47	8.03	13.9	6.52	12.87
	Number of spickelets/spike	17.73	23.53	25.60	24.20	13.27	35.60	27.93	25.33
	Spike weight (gm)	3.26	3.37	0.89	4.10	2.33	4.20	1.11	2.38
Rachis	Degree of axial erection	Medium	Low conspicuous	Very conspicuous	Medium	Medium	Medium	Very conspicuous	Very conspicuous
	Presence of hairs	-	-	-	+	+	+	-	+
	Homogeneity of axial internode	Homo.	Hetero	Homo.	Homo.	Homo.	Homo.	Hetem.	Homo.
	Average internode length (mm)	4.5	8.6	3.4	4.1	5.9	5.2	4.4	4.5
	Arrangement of basal internode of infl. in relation to the neck internode	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Oblique	Vertical
	Arrangement of spikelets on the rachis	Whorled	Two opposite rows	Two opposite rows	Whorled	Whorled	Whorled	Two opposite rows	Whorled
	Spikelets intensity	intermedia te	Lower dense	Very dense	intermediate	intermediate	intermediate	Very dense	intermediate
	Separation of spikelets with axial parts at the maturity stage	-	-	-	-	+	-	-	-
	Presence of furrows on basal internode of the neck region	Very conspicuo us	absent	Less conspicuous	Less conspicuous	Less conspicuous	Less conspicuous	Less conspicuous	Less conspicuous
	Presence of sheath on basal internode of the neck region	-	-	-	-	-	-	+	-

+ = Present - = Absent Homo. = Homogeneous Hetero. = Heterogeneous

Table (2): Morphological characters of lower glumes of eight *Triticum* species taken at spike formation

Species / Recorded data	*Triticum aestivum*	*Triticum spelta*	*Triticum monococcum*	*Triticum timopheevii*	*Triticum dicoccoides*	*Triticum durum*	*Triticum paleocolchicum*	*Triticum polonicum*
Glume texture	Skinny	Skinny	Skinny	Skinny	Skinny	Skinny	Skinny	Membranous
Position of glumes in relation to other flower parts	Short	Short	Short	Short	Short	Short	Short	Long
Presence of keel	+	+	+	+	-	+	+	+
Keel length	Long	Short	Short	Short	Absent	Short	Short	Short
Glume shape in outline	Oblong	Oblong	Curved linear	Narrow ovate	Elliptic	Narrow ovate	Curved linear	Linear
Glume apex	Truncate	Obtuse	Emarginate	Acuminate	Acute	Acuminate	Obtuse	Obtuse
Presence of hairs on glumes	-	-	-	+	+	-	-	-
Average maximum length of glume (mm)	12	13	8	14	15	15	10	28
Average of maximum width of glume (mm)	4.5	4.0	2.0	4.0	3.0	2.9	2.2	2.9

+ = Present - = Absent Long = 6 mm Short = 1 – 3 mm

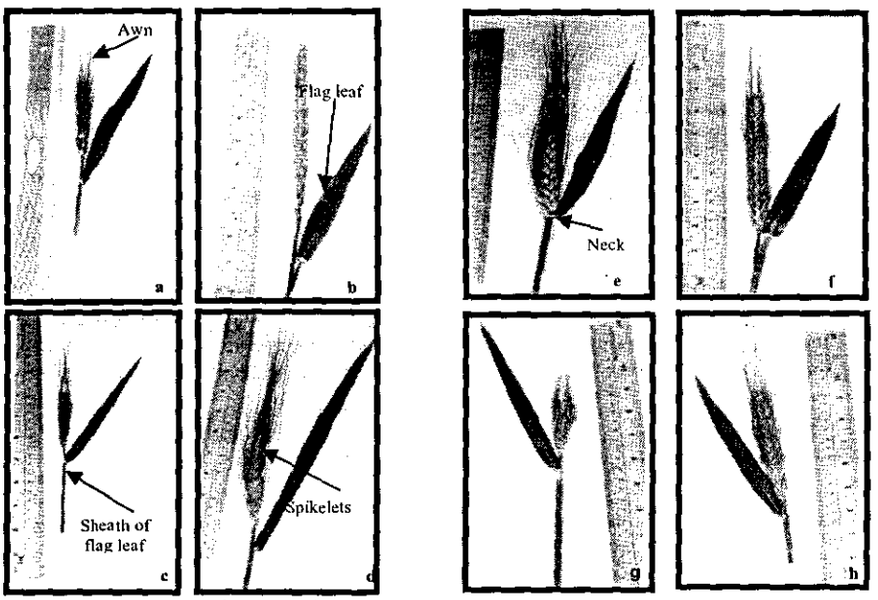

Figure (1): Showing the morphology of the spike of *Triticum* species.
a-T. aestivum b- *T. spelta* c: *T. monococcum* d: *T. timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

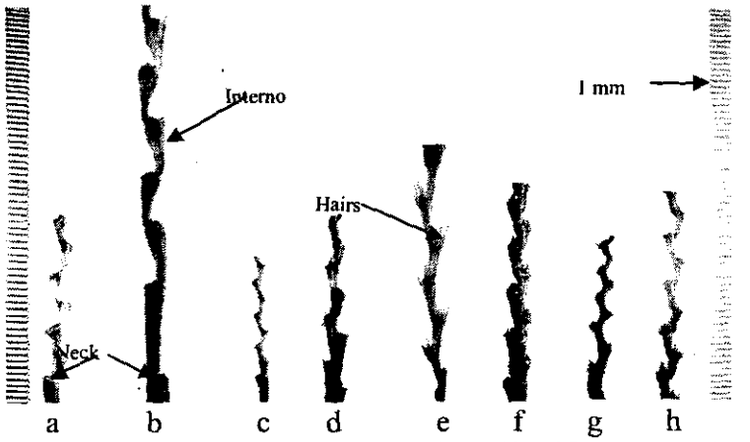

Figure (2): Showing the morphology of the rachis of *Triticum* species

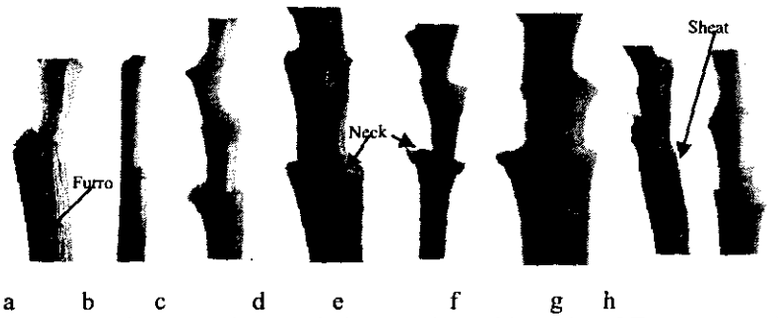

Figure (3): Showing the morphology of the rachis necks of *Triticum* species

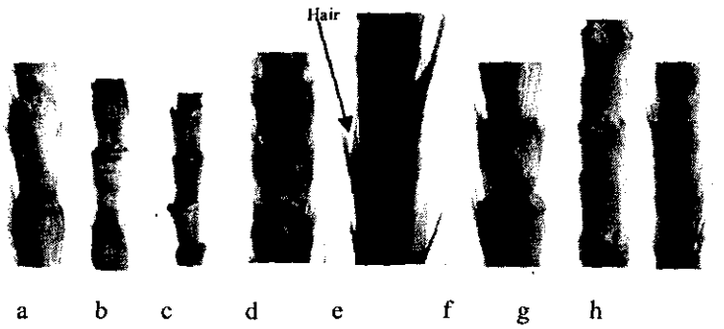

Figure (4): Showing the morphology of the rachis internodes of *Triticum* species

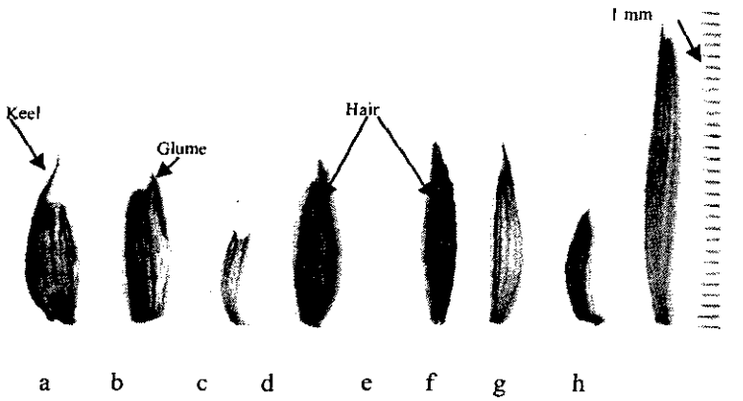

Figure (5): Showing the morphology of the lower glumes of *Triticum* species

a: *T. aestivum* b: *T. spelta* c: *T. monococcum* d: *T.timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

Table (3): Morphological characters of lemma and palea of eight *Triticum* species taken at spicke formation

Species / Recorded data		*Triticum aestivum*	*Triticum spelta*	*Triticum monococcum*	*Triticum timopheevii*	*Triticum dicoccoides*	*Triticum durum*	*Triticum paleocolchicum*	*Triticum polonicum*
Lemma	Lemma shape in outline	Oblomg	Narrow ovate	Oblong	Linear	Oblong	Narrow ovate	Ovate	Linear
	Lemma apex	Obtuse	Acute	Obtuse	Acute	Truncate	Acute	Acute	Obtuse
	Presence of horn	+	-	+	-	-	-	-	-
	Average maximum length of lemma (mm)	12.0	13.0	10.0	16.0	15.0	17.5	11.0	22.0
	Average maximum width of lemma (mm)	3.5	3.5	3.0	3.3	3.5	4.7	3.3	3.5
Palea	Palea shape in outline	Ovate	Ovate	Linear	Very narrow ovate	Very narrow ovate	Lanceolate	Ovate	Linear
	Palea apex	Obtuse	Obtuse	Truncate	Acute	Acute	Acute	Acute	Truncate
	Palea splitting at maturity stage	-	-	+	-	-	-	-	-
	Average maximum length of palea (mm)	10.5	11.1	9.1	12.0	13.1	11.7	10.0	10.0
	Average maximum width of palea (mm)	3.5	3.2	1.6	2.5	2.8	2.3	2.4	1.9

+ = Present - = Absent

Table (4): Anther morphology and SEM of pollen grains of eight *Titicum* species taken at spike formation

Species / Recorded data		*Triticum aestivum*	*Triticum spelta*	*Triticum monococcum*	*Triticum timopheevii*	*Triticum dicoccoides*	*Triticum durum*	*Triticum paleocolchicum*	*Triticum polonicum*
Anther	Average maximum length (mm)	3.5	2.9	4.5	4.0	3.3	6.2	2.6	3.7
	Average maximum width (mm)	0.7	0.7	0.6	0.8	0.6	1.00	0.5	0.7
	Average horn length (mm)	0.8	0.6	0.2	0.6	0.7	0.7	0.4	1.1
Pollen grains	Pollen grain shape	Spherical	Spherical	Spherical	Ovate	Pear-shaped	Spherical	Spherical	Spherical
	Maximum diameter of pollen grain (µm)	43.30	44.40	35.50	41.40	45.52	37.74	39.96	34.41
	Pollen grain area ((µm2)	1491	1493	972	1259	1493	1070	1192	935
	Maximum diameter of ectoaperture pore (µm)	-	-	10.5	12.76	12.76	11.10	14.76	10.40
	Maximum diameter of endoaperture pore (µm)	-	-	4.83	3.88	3.88	4.44	4.99	3.06
	Thickness of pore wall (µm)	3.70	4.10	3.35	4.44	4.44	3.83	4.81	3.30
	Presence of operculum on pore	+	+	-	-	-	-	-	-

+ = Present - = Absent

Table (5): Morphological characters of grains of eight *Titicum* species taken at harvest time

Species / Recorded data		*Triticum aestivum*	*Triticum spelta*	*Triticum monococcum*	*Triticum timopheevii*	*Triticum dicoccoides*	*Triticum durum*	*Triticum paleocolchicum*	*Triticum polonicum*
Grains	Number of grains/spike	40.13	35.4	18.2	45	21	61.13	23.93	31.2
	Weight of grains/spike (gm)	2.35	1.98	0.57	2.72	0.88	2.49	0.69	1.52
	Number of grains/spikelet	2.27	1.5	0.7	1.84	1.53	1.74	0.87	1.23
	100 grains weight (gm)	6.22	5.68	3.21	5.85	4.25	4.02	2.79	4.92
	Grain length (cm)	0.71	0.83	0.71	0.85	0.95	0.78	0.70	0.82
	Grain width (cm)	0.38	0.33	0.20	0.33	0.26	0.31	0.24	0.31
	Grains separable from lemma and palea on threshing	Easily	Not easily	Not easily	Easily	Not easily	Easily	Not easily	Easily
Embryo	Shape in outline	Rounded	Obovate	Wedge-shaped	Obovate	Oblong	Obovate with mucronate base	Rounded	Oblong
	Average maximum length (mm)	3.0	2.4	1.6	2	3.4	2.2	1.4	3.2
	Average maximum width (mm)	2.4	1.4	0.8	1.8	1.6	1.6	1.4	1.6

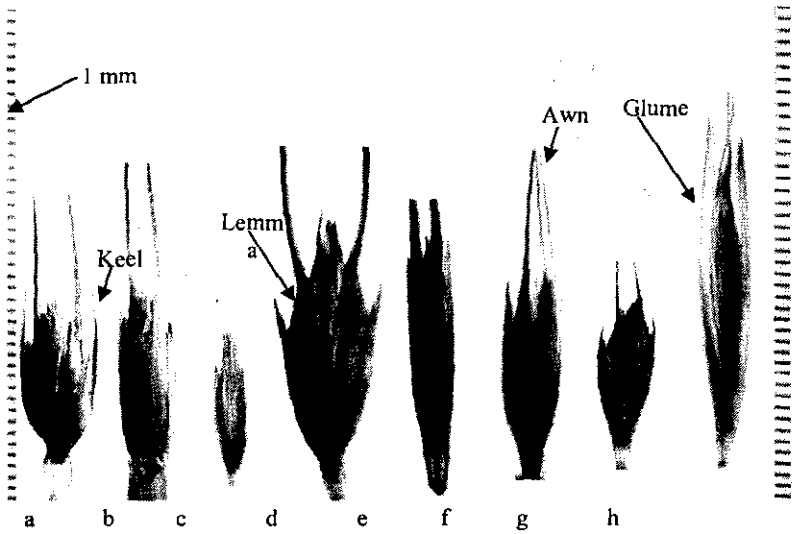

Figure (6): Showing the morphology of the spikelets of *Triticum* species
a: *T. aestivum* b: *T. spelta* c: *T. monococcum* d: *T.timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

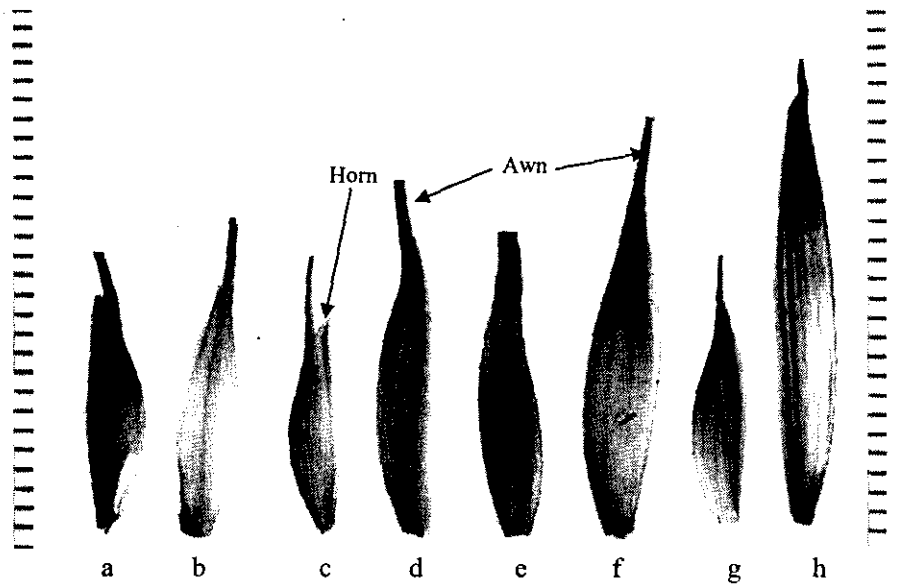

Figure (7): Showing the morphology of the lemma of *Triticum* species

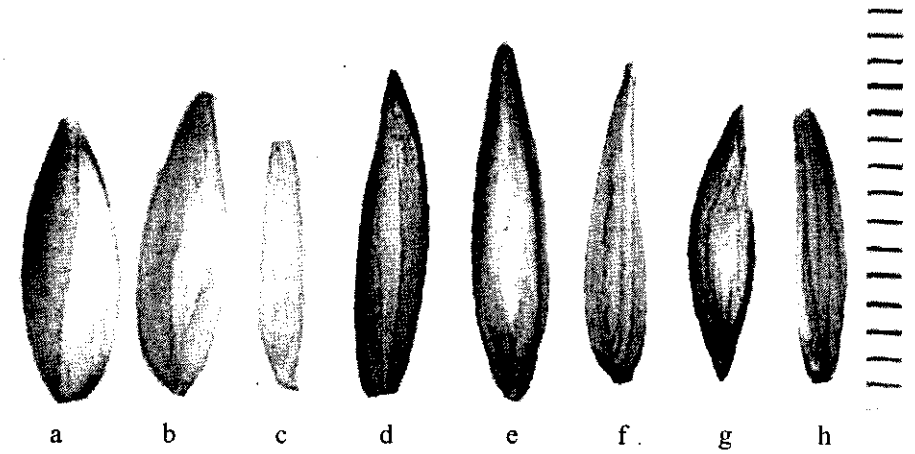

Figure (8): Showing the morphology of the palea of *Triticum* species
a: *T. aestivum* b: *T. spelta* c: *T. monococcum* d: *T.timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

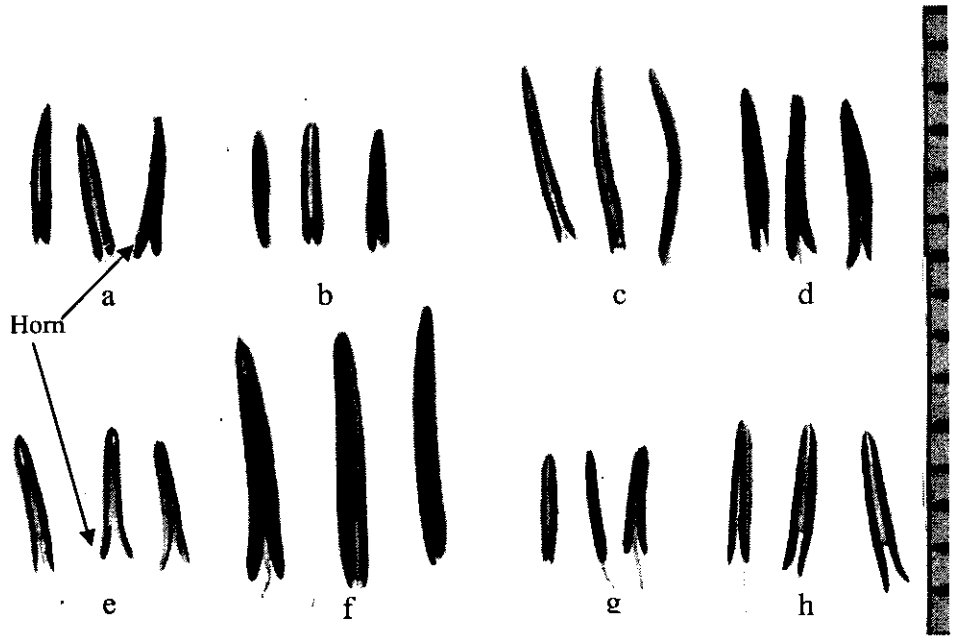

Figure (9): Showing the morphology of the anthers of *Triticum* species

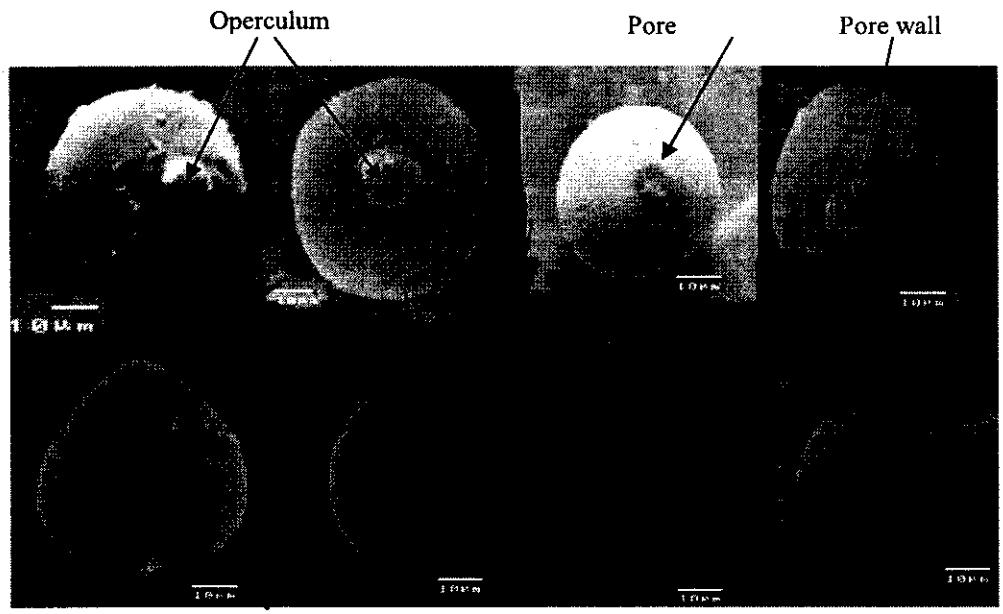

Figure (10): Showing the scanning electron micrographs of the pollen grains of *Triticum* species
a: *T. aestivum* b: *T. spelta* c: *T. monococcum* d: *T.timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

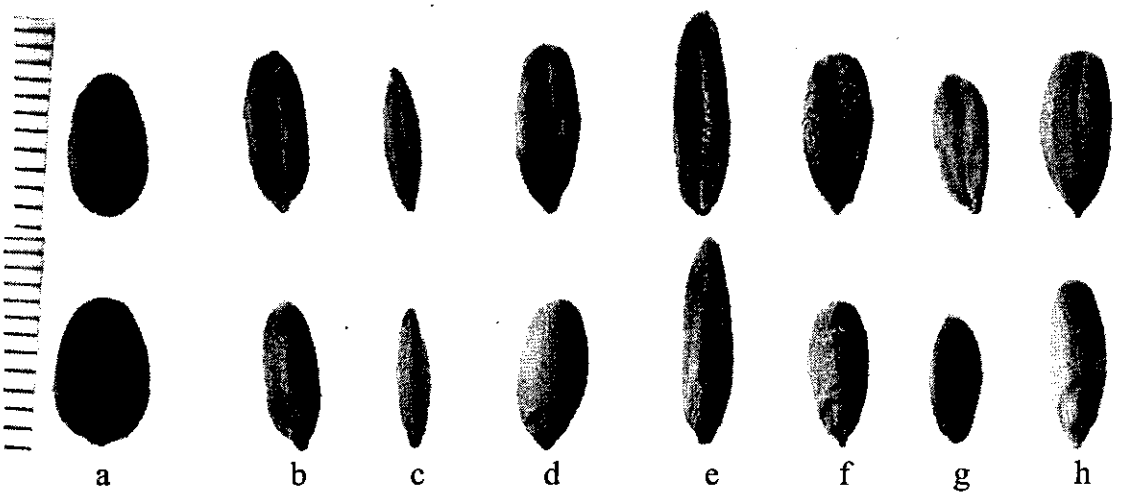

Figure (11): Showing the morphology of mature grains of eight *Triticum* species
a: *T. aestivum* b: *T. spelta* c: *T. monococcum* d: *T.timopheevii*
e: *T. dicoccoides* f: *T. durum* g: *T. paleocolchicum* h: *T. polonicum*

Triticum species. Furthermore, the maximum values of maximum length of lemma (22.0mm) and maximum width of lemma (4.7mm) were recorded in *T.polonicum* and *T.durum* (Fig.7h and f), respectively. While, the minimal values of their parameters (10.0 and 3.0mm) were noticed in *T.monococcum* (Fig.7c). Similar results were obtained by Townsend and Guest (1968), Zohary (1972), Frank and Robert (1983), Lersten (1987) and Mandaville (1990) who observed that lemma are navicular,, keeled towards the apex, awned or unawned and rounded on the back.

c- Palea:-

Data in Table (3) and Figure (8) show that palea shape was ovate in *T.aestivum*, *T.spelta* and *T.paleocolchicum* (Fig.8a,b and g), linear in both *T.monococcum* and *T.polonicum* (Fig.8c and h), very narrow ovate in both *T.timopheevii* and *T.diciccoides* (Fig.8d and e). and lanceolate in *T.durum* (Fig.8f). Furthermore, palea apex was obtuse in both *T.aestivum* and *T.spelta* (Fig.8a and b), truncate in both *T.monococcum* and *T.polonicum* (Fig.8c and h) and acute in the other *Triticum* species (Fig.8d, e, f and g). However, palea splitting at maturity stage was observed in *T.monococcum* only (Fig.8c). The highest values of maximum length of palea (13.1mm) and maximum width (3.5mm) were found in *T.dicoccoides* and *T.aestivum* (Fig.8e and a), respectively. Whereas, the lowest values of their parameters (9.1 and 1.6mm) were recorded in *T.monococcum* (Fig.8c). These results are in agreement with those obtained by Townsend and Guest (1968) who pointed out that palea of *Triticum* species has 2-nerved, ciliate on the keels and sometimes split (as in *T.monococcum*).

d- Anther and pollen grains:-

Results in Table (4) and Figures (9 and 10) reveal that maximum values of anther length (6.2mm), anther width (1.0mm) were recorded in *T.durum* (Fig.9f) and (1.1mm) for horn length as noticed in *T.polonicum* (Fig.9h). Whereas, the lowest values of anther length and width (2.6 and 0.5mm) were observed in *T.paleocolchicum* (Fig.9g) and (0.2mm) for horn length in *T.monococcum* (Fig.9c).In addition, pollen grain shape was ovate in *T.timopheevii* (Fig.10d), pear-shaped in *T.dicoccoides* (Fig.10e) and spherical in the other studied *Triticum* species (Fig.10a,b,c,f,g and h). The highest values of maximum pollen grain diameter (45.52µm) and pollen grain area (1493 µm2) were observed in *T.dicoccoides* (Fig.10e); also, the maximum values of maximum diameter of ectoapeture pore pollen (14.76 µm), maximum diameter of endoaperture pore pollen (4.99 µm) and thickness of pore wall pollen (4.81 µm) were observed in *T.paleocolchicum* (Fig.109). But, the minimal values in their pollen grain parameters were 34.41 µm, 935 µm2, 10.40 µm, 3.06 µm and 3.30 µm, respectively in *T.polonicum* (Fig.10h). On the other hand, presence of operculum on pollen grain pore was observed in both *T.aestivum* and *T.spelta* only (Fig.10a and b). These results are in harmony with those obtained by Dahlgren and Clifford (1982) who observed that the pollen grains of *T.aestivum*

were ulcerate (monopore), operculate and surrounded by wall defined annular thickness.

e- Grains:-

It is seen from Table (5) and Figure (11) that the maximum values of both number of grains/spike (61) and weight of grains/spike (2.49gm) were observed in *T.durum* (Fig.11f), 100 grains weight (6.22gm) and grain width(0.38cm) were recorded in *T.aestivum* (Fig.11a) and grain length (0.95cm) in *T.dicoccoides* (Fig.11e). While, the minimal values of number of grains/spike (18), weight of grains/spike (0.56gm) and grain width (0.20cm) were shown in *T.monococcum* (Fig.11c); but, the minimal values of 100 grain weight (2.79gm) and grain length (0.70cm) were observed in *T.paleocolchicum* (Fig.11g). Moreover, number of grains/spikelet were one in *T.monococcum*, *T.paleocolchicum* and *T.polonicum* and two grains/spikelet in the other studied *Triticum* species. The embryo shape was rounded in both *T.aestivum* and *T.paleocolchicum* (Fig.11a and g), obovate in both *T.spelta* and *T.timopheevii* (Fig.11b and d), wedge-shaped in *T.monococcum* (Fig.11c), oblong in both *T.dicoccoides* and *T.polonicum* (Fig.11e and h) and obovate with mucronate base in *T.durum* (Fig.11f). Moreover, the highest values of maximum embryo length (3.4mm) and maximum embryo width (2.4mm) were observed in *T.dicoccoides* and *T.aestivum* (Fig.11e and a), respectively. While, the lowest values of maximum embryo length (1.4mm) and maximum embryo width (0.8mm) were noticed in *T.paleocolchicum* and *T.monococcum* (Fig.11g and c), respectively. These results are in agreement with those obtained by Lersten (1987) who found that the grain shape was obovate, elleptical or oval, hairy at the apex and deeply grooved adaxillary embryo about 1/5 length of caryopsis.

Data of this research can be used to differentiate among the eight *Triticum* species under study as given in the following key:-

I-Arrangement of spikelets on the rachis in two opposite rows, no hairs on the rachis

A-Basal internode of inflorescence in relation to the neck internode vertical, absent of sheath on basal internode of the neck region

a-Shape of glume in outline oblong, glume apex obtuse ***T. spelta***

aa-Shape of glume in outline curved-linear, glume apex emarginated ***T. monococcum***

AA-Basal internode of inflorescence in relation to the neck internode oplique, presence of sheath on basal internode of the neck region ***T. paleocolchicum***

II-Arrangement of spikelets on the rachis whorled, hairs present on the rachis

B-Glume texture skinny, glumes short in relation to the other flower parts

C-Keel absent ***T. dicoccoides***

CC-Keel present

D-Length of keel 1-3 mm, glume apex acuminate

E-Hairs present on glume ***T .timopheevii***

EE-Hairs absent on glume ***T. durum***

DD-Length of 6 mm keel, glume apex truncate ***T. aestivum***

BB-Glume texture membranous, glumes long in relation to the other flower parts ***T. polonicum***

REFERENCES

Belay, G.; E. Bechere; D. Mitiku; A. Merker and S. Tsegaye (1997). Patterns of morphological diversity in tetraploid wheat (*Triticum turgidum* L.) landraces from Ethiopia. Acta Agriculture Scandinavica. Section-B Soil and Plant Science.47: 4, 221-228

Cervantes, M.; F. Copado; M. Cervantes; R. Soto; N. Torrentera and J. L. Figueroa (2002). Prediction of amino acid content in wheat based on its protein value. Interciencia.27: 12, 695-701.

Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia Univ. Press New York. P. 1142-1147.

Dahlgren, R. M. and H. T. Clifford (1982). The monocotyledons: A comparative study. Academic press INC. (London) LTD. 151-158.

Davis, P. H. and V. H. Heywood (1991). Today and tomorrow's printers and publishers 14B/5, D.B. Gupta Road, Karol Bagh New Delhi, 183-185.

Elings, A. (1991). Durum wheat landraces from Syria. II. Patterns of variation. Euphytica. 54: 3, 231-243

Erdetman, G. (1966). Sporoderm morphology and morphogensis. A collection of data and suppositions. Grana polynol. 6. 318-323.

Frank, W. and B. S. Robert (1983). Grass systematic 2nd Ed, Texas University, Press p. 26-29.

Harley, M. M. and L. K. Fergusen (1990). The role of SEM in pollen morphology and systematic. In: Scanning Electron Microscope, studies in taxonomy and functional. Ed. By Clangher D. Systemics Association Special Volume, 41: 45-68, Clarendon Press, Oxford. UK.

Jones, S.B. and Luchsinges, A.E. (1987). Plant systematics 2nd Ed. McGraw-Hill. Inc., N.Y. p438.

Lersten, N. R. (1987). Morphology and anatomy of the wheat plant. Wheat and wheat improvement 2nd Ed. P: 33-74.

Mandaville, J. P. (1990). Flora of Eastern Saudi Arabia. Kegan Paul International London and New York, 386-387.

Miller,T. E.; E. J. Lamont; L. Pena-Chocarro; S. M. Reader and M. J. Ambrose (1999). Present-day hulled wheats from Spain. Cereal Research Communications. 27: 3, 273-279.

Moore, P. D.; J. A. Webb and M. E. Collinson (1991). Pollen analysis 2nd Ed. Oxford, Blackwell Scientific publications, London. 68-71.

Slafer, G. A. and D. J. Miralles (1993). Fruiting efficiency in three bread wheat (*Triticum aestivum*) cultivars released at different eras. Number of grains per spike and grain weight. Journal of Agronomy and Crop Science. 170: 4, 251-260.

Szwed-Urbas, K.; W. Swiecicki and B. Naganowska (2002). Differentiation of biometric features in the *Triticum durum* Desf. Limitation for the future. Proceedings of the XVIth EUCARPIA Genetic Resources Section workshop, Poznan, Poland, 16-20

Townsend, C. C. and E. Guest (1968). Flora of Iraq. Volume 9. published by the Ministry of Agriculture of the Republic of Iraq. P. 194-209.

Watson, L. and M. J. Dallwitiz (1992). The grass of the world, Canberra ACT 2601 Australian. P. 946-947.

Zohary, M. (1972). Flora Paleastina. Part 2, Israel Academy of Science and Humanities. P. 177-178.

تمييز بعض أنواع القمح بصفات النورة

عبد الرحمن عليوة حسن– محمد محمد السعيد عبد الهادي صقر- عبد الغني إبراهيم عمر باز – صلاح محمد حسن جويد
قسم النبات الزراعي – كلية الزراعة – جامعة قناة السويس – الإسماعيلية - مصر

تم الحصول على ٨ أنواع من جنس القمح من مصادر مختلفة (٦ أنواع استوردت من مركز CIMMYT بالمكسيك ونوع واحد من مركز ICARDA بسوريا ونوع واحد من مركز NSGC بأمريكا). زرعت هذه الحبوب لأنواع القمح المختلفة تحت ظروف موحدة في مزرعة كلية الزراعة التجريبية جامعة قناة السويس محافظة الإسماعيلية في نوفمبر ٢٠٠٣ لدراسة مورفولوجيا النورة. وقد أمكن التوصل للنتائج التالية:-

أظهرت الصفات المورفولوجية لكل من النورة السنبلية ومحورها والسنيبلات (القنابع والعصيفات الداخلية والخارجية) وحبوب اللقاح والحبوب اختلافات بين الأنواع. غياب الشعيرات علي محور السنبلة صفة مميزة للأنواع *Triticum spelta* و *T. paleocolchicum* و *T. monococcum* . كان مستوى السلامية القاعدية لمحور النورة مع منطقة الرقبة مائل في *T. paleocolchicum* بينما كان عمودي في باقي الأنواع. لوحظ انفصال السنيبلات مع جزء من المحور عند مرحلة النضج فقط في النوع *T. dicoccoides* مقارنا بباقي الأنواع المدروسة. علاوة علي ذلك ظهر غمد عند قاعدة السلامية القاعدية في منطقة الرقبة في النوع *T. paleocolchicum* بينما كان غائب في باقي الأنواع. علاوة علي ذلك كانت طبيعة القنا بع غشائية، والشكل الشريطي للقنا بع وأطوالها صفات مميزة للنوع *T. polonicum* بالمقارنة بالأنواع المدروسة. بالإضافة إلي ذلك ظهور نتوء في كل من الـ *T. monococcum* و*T. aestivum* وغائب في باقي الأنواع. لوحظ انقسام العصيفة الداخلية عند مرحلة النضج في النوع *T. monococcum* فقط. فضلا علي ذلك كان شكل حبوب اللقاح بيضي في *T. timopheevii* وكمثري في *T. dicoccoides* وكروي في باقي الأنواع. لوحظ وجود غطاء لثقب الإنبات لحبة اللقاح في *T. spelta* و*T. aestivum* .

بالإضافة إلي ذلك فإن كل القياسات المدروسة بين أنواع القمح أظهرت اختلافا واضحا بين الأنواع.