

# COMPARATIVE MORPHOLOGICAL AND ULTRASTRUCTURAL STUDIES ON GRAINS OF SOME POACEAE SPECIES.

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## ABSTRACT

Morphology and grain features of eleven species belong to six genera of family Poaceae namely; *Setaria viridis* (L.) Beauv., *Setaria pumila* (Poir.) Roemer et Schultes, *Panicum turgidum* Forssk., *Panicum coloratum* L., *Echinochloa colonum* (L.) Link., *Echinochloa crusgalli* (L.) P.Beauv., *Cenchrus ciliaris* L., *Cenchrus echinatus* Vahl., *Brachiaria reptans* (L.) Gardner et Hubb., *Brachiaria eruciformis* (Sibth & Sm.) Griseb. and *Paspalidium geminatum* (Forssk.) Stapf were studied .

The objective of this investigation was to distinguish the relationship among the studied species (OTUs= Operational Taxonomic Unit) by using their morphological characters and the Scanning Electron Microscopy (SEM) of their grain surfaces. Single Linkage Clustering analysis technique was carried out to analyze these features.

From the morphological results, it could be recognized that the species of genus *Panicum* (*P. turgidum* and *P. coloratum*) were more close, firstly, to each other then to *S. pumila*. Also, the species represent genus *Echinochloa* (*E. colonum* and *E. crusgalli*) were close, firstly to *S. viridis*, then to the cluster included species of *Panicum* and *Setaria*. The only surprising result was with the species represent genus *Cenchrus*; where *C.echinatus* joined with *Panicum* cluster, while *C. ciliaris* linked with the cluster included species of genus *Brachiaria* and *Paspalidium geminatum*.

Grain surface sculptures appearance and shape are considered the most diagnostic taxonomic characters to differentiate among the studied species. There are eleven features of the grain surface sculptures were observed by using SEM. The numerical technique analysis showed that, on the highest taxonomic similarity level 1.14, the studied species divided into two major clusters; one included species of *Brachiaria*, *Cenchrus* and *Paspalidium* and the other contained two clusters; one with species of genus *Panicum*, *C. echinatus* and *S. pumila*. The other with species of genus *Echinochoa* and *S.viridis*. Key using morphological and grain surface features was proposed.

## INTRODUCTION

Family Poaceae (Gramineae) is one of the largest families of the flowering plants. It comprises some 620 genera and 10000 species (Clayton, 1970). If the family judged by the number of species, the regions which they covered and the frequency of habitats they are spread, the family Poaceae is the most successful one among all the flowering plants.

Poaceae are widely spread in all parts of the universe. The areas of grass plants ranging from the equator to near the poles. Grass plants could be found in prairies, steppes, meadows and savannas. They extend from sea level to the permanent snow on mountains. They grow in different soil types; in wet and dry regions, adapted with all the situations between these regions (Clayton, 1970).

Täckholm (1974) reported that Poaceae are represented in the Egyptian flora by 93 genera and 224 species. Khanagrey (2000) mentioned that the number of genera is 95 represented by 230 species.

Poaceae are one of the greatest families of flowering plants as food crops for the human consumption; included rice, wheat, corn, barley and sugar cane. In addition, Poaceae plants are considered as sources of; forage and grain for animals; soil conservation; ornamental plants and shelter bamboo (which used for building construction and paper manufacturing). Aromatic oil is also extracted from grass plants and used in manufacturing soap and perfume. Starch and ethyl alcohol which are used in many different industrial process are also obtained from the grass plants (Jones and Luchsinger, 1987).

The aim of the present study was to represent relationships among eleven species of Poaceae using morphological description for each studied grass plant and grains, Scanning Electron Microscopy (SEM) of the grain surface of each taxon and applying the Single Linkage Clustering technique (Abbott *et al.*, 1985) to analyze the obtained data. Finally, a key using all the available morphological and grain features was proposed.

The reason for choosing these particular species is due to the taxonomic position problem of some species under some genera; e.g. the similarity between *Echinochloa*, *Setaria* and *Panicum*. Watson *et al.* (1985) stated that the subfamily Panicoideae was split into two tribes. One of these tribe was Paniceae with both genera *Echinochloa* and *Setaria*. While, Yossef *et al.* (2003), reported that the tribe Panicoideae included both species of genus *Echinochloa*, in the time, where *Setaria pumila* stay away under another tribe; *Setaria* due to the variations observed in many different morphological and grain surface features between these genera.

The present study was considered as an attempt to solve the abovementioned problem, in addition to evaluate the taxonomic position of genera *Cenchrus*, *Paspalidium* and *Brachiaria*.

## MATERIALS AND METHODS

Eleven species of Poaceae representing six genera were studied (Table1). The study was concentrated on the herbarium specimens and grains representing these species. Materials were obtained through the curtesy of Herbarium and Gene bank of the Flora and Phyto-taxonomy Researches Department (CAIM), Horticultural Research Institute, Agricultural Research Center, Dokki, Giza. In addition, some possible fresh plants (represent species of *Echinochloa*, *Setaria* and *Panicum* ) were collected from different areas around Giza, Fayioum and Kafr El-Sheikh cities.

Five herbarium specimens, beside fresh ones when possible, representing each species were used, to measure and describe the morphological characters. Grains of the studied species was used for SEM examination. To ensure the identification of each herbarium specimens is correct, some flora books were consulted (Täckholm, 1974, Clayton, 1970 and Albina, 1999).

SEM were used to gain more information about features of the grain surface. According to the grain size, the magnification power was represented by Kv =10 and x between 250 to 7000 for each SEM photograph, either for the whole grain or the grain surface sculptures. SEM-photographs were obtained after mounting the dry grain with SPI supplies on copper stubs and coated with a layer of gold palladium in Edwards Sputter Coater Unit, S 150 B. Scanning was carried out using JEOL-JSM T 100 Model Scanning Electron Microscope at National Information and Documentation Center (NIDOC), Dokki, Giza, Egypt.

The qualitative and quantitative features of the grains of each species were recorded using binocular Stereo-microscope. Descriptive terms of grain surface scan resemble that of Murley, (1951).

Phenetic analysis using Single Linkage Clustering technique (Sneath & Sokal, 1973) was employed and concentrated on the species level, where the individual specimen, Operational Taxonomic Unit (OTU), will represent species. Characters studied (29 characters) include the morphology of the whole plant and grain, in addition to the SEM features of the grain surface.

## RESULTS AND DISCUSSION

This investigation was carried out to evaluate the relationships between 11 species belong to 6 genera of Poaceae (Table1). Morphological characters of the grains and the whole plant, grain surface and the numerical analysis were presented in the forms of accumulative tables, plates, micro-photographic pictures and dendrogram in order to facilitate the similarity and/or dissimilarity between the studied.

Table (1): Name and habit of studied species.

Genera	Species	Habit
<i>Setaria</i> P.Beauv.	<i>S. viridis</i> (L.) Beauv. (= <i>Panicum viride</i> L.) <i>S. pumila</i> (Poirlet) Roemer & Schultes (= <i>S. glauca</i> auct. Non (L.) P.Beauv., <i>Panicum glueum</i> L.)	Wild, annual weed
<i>Panicum</i> L.	<i>P. turgidum</i> Forssk <i>P. coloratum</i> L.	Wild, perennial weed
<i>Echinochloa</i> P.Beauv.	<i>E. colonum</i> (L.) Link (= <i>Panicum colonum</i> ) <i>E. crusgalli</i> (L.) P.Beauv. (= <i>Panicum crus galli</i> L., <i>P. hispidum</i> Forssk.)	Wild, annual weed
<i>Cenchrus</i> L.	<i>C. ciliaris</i> L. (= <i>Pennisetum ciliare</i> (L.) Link.) <i>C. echinatus</i> Vahl.	Wild, perennial Wild, annual, perennial
<i>Brachiaria</i> Griseb.	<i>B. reptans</i> (L.) Gardner et Hubb. (= <i>Urochloa reptans</i> (L.) Stapf, <i>Panicum reptans</i> L., <i>P. prostratum</i> Lam.) <i>B. eruciformis</i> (Sibth. & Sm.) Griseb (= <i>B. isachne</i> Stapf, <i>P. eruciforme</i> Sibth & Sm.)	Annual weed
<i>Paspalidium</i> Stapf	<i>P. geminatum</i> (Forssk.) Stapf (= <i>Panicum geminatum</i> Forssk.).	Perennial weed

### 1- Plant Morphology

The morphological and grain surface features of the studied species are represented in Table (2) and illustrated in Figure (1) and Plates (1&2) as follows:

Table (2) : Morphological descriptions of the vegetative and reproductive characters of the studied species.

Characters	Species	<i>Setaria viridis</i>	<i>Setaria pumila</i>	<i>Panicum turgidum</i>	<i>Panicum coloratum</i>	<i>Echinochloa colonum</i>	<i>Echinochloa crusgalli</i>	<i>Cenchrus ciliaris</i>	<i>Cenchrus echinatus</i>	<i>Brachiaria reptans</i>	<i>Brachiaria eruciformis</i>	<i>Paspallidium geminatum</i>
Vegetative characters												
1- plant duration		annual	annual	perennial	perennial	annual	annual	perennial	annual	annual	annual	perennial
2- stem position		erect	erect	erect	erect	erect	erect	erect	erect	erect	erect	Knead at base
3- stem texture		glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	glabrous
4- stem branching		at lower part	at lower part	at lower part	at lower part	at lower part	at lower part	at lower part	at lower part	at lower part	at lower part	at lower & upper parts
5- stem thickness		thin	thin	thick	thin	thin	thin	thin	thin	thin	thin	thick
6- stem shape		cylindrical	composed	cylindrical	cylindrical	cylindrical	cylindrical	composed	composed	cylindrical	cylindrical	cylindrical
7- internode texture		solid	solid	hollow	solid	solid	solid	solid	solid	hollow	hollow	hollow
8- leaf length cm		less 15	less 15	More 15	less 15	less 15	less 15	less 15	less 15	less 15	less 15	less 15
9- leaf width mm		up to 5	up to 7	up to 7	less 7	less 7	less 7	less 7	less 7	up to 7	up to 7	up to 7
10- leaf blade edge		hairy	hairy	glabrous	glabrous	glabrous	glabrous	hairy	hairy	hairy	hairy	glabrous
11- leaf blade texture		glabrous	hairy	glabrous	glabrous	glabrous	glabrous	hairy	hairy	hairy	hairy	glabrous
12- ligule presence		present	present	present	present	absent	absent	present	replaced by rim of hair	replaced by rim of hair	present	Present
13- sheath shape		cylindrical	cylindrical	cylindrical	composed	composed	composed	composed	composed	cylindrical	cylindrical	composed
14- sheath texture		hairy	hairy	hairy	glabrous	glabrous	glabrous	hairy	hairy	hairy	hairy	glabrous
15- sheath edge		un-membranous	un-membranous	un-membranous	un-membranous	un-membranous	un-membranous	membranous	membranous	membranous	membranous	membranous
Reproductive characters												
16- inflorescence type		close panicle	close panicle	open panicle	close panicle	close panicle	close panicle	spike	Spike	Spike	spike	spike
17- arrangement of spikelet		irregular	irregular	regular	regular	regular	irregular	irregular	irregular	regular	regular	Regular
18- rachis texture		hairy	hairy	glabrous	glabrous	glabrous	glabrous	hairy	hairy	glabrous	glabrous	Hairy
19- No. of flower/ spikelet		2	2	1	2	2	2	Several	several	1	1	1
20- glume texture		glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	hairy	hairy	smooth	glabrous	Glabrous
21- lemma texture		glabrous	glabrous	glabrous	glabrous	glabrous	glabrous	hairy	hairy	glabrous	glabrous	Glabrous
22- awn presence		absent	absent	absent	absent	absent	absent	present	absent	absent	absent	Absent

Table (2.cont.): Morphological description of the grain surface of the studied species by using SEM.

Characters	Species	<i>Setaria viridis</i>	<i>Setaria pumila</i>	<i>Panicum turgidum</i>	<i>Panicum coloratum</i>	<i>Echinochloa crus-galli</i>	<i>Cenchrus ciliaris</i>	<i>Cenchrus echinatus</i>	<i>Brachiaria reptans</i>	<i>Brachiaria eruciformis</i>	<i>Paspalidium geminatum</i>
The grain											
1- grain shape		elliptic	broadly elliptic	broadly elliptic	elliptic	elliptic	rectangular or oblong	ovoid	elliptic	broadly elliptic	lanceolate ovoid
2- grain texture		smooth	smooth	smooth	smooth	smooth	Creamy brownish	smooth	smooth	Smooth	Smooth
3- grain colour		grey	black or maroon	creamy to dark brown	creamy to dark brown	grey		creamy brownish	creamy or black	creamy or black	dark brown
4- grain length mm		1.8	3.0	2.5	2.4	1.8	2.8	3.0	1.6	1.4	1.8
5- grain width mm		1.0	2.0	2.0	2.0	1.2	0.9	2.0	0.9	0.6	1.0
6- grain grade(LXW)		1.8	6.0	5.0	4.8	2.2	2.5	6.0	1.4	0.8	1.8
		S	L	L	L	S	M	L	S	S	S
7- Grain surface sculptures appearance		ruminate	favulariate-siriate	rugose-scalaniform	pusticulate	favulariate-foveate	rugose	foveate	reticulate-foveate	Glebulate	verruculatereticulate



*Setaria viridis*



*Setaria pumila*



*Panicum turgidum*

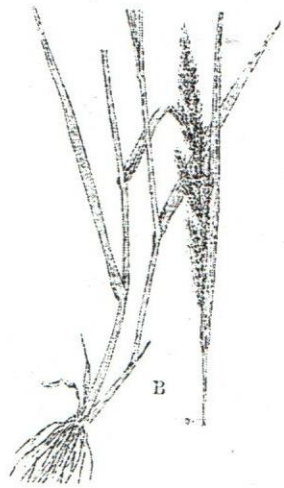


*Panicum coloratum*

Fig. (1): Drawings illustrating habit of 11 plant species under investigation.



*Echinochloa colonum*



*Echinochloa crusgalli*



*Cenchrus ciliaris*



*Cenchrus echinatus*

Fig. (1 cont.): Drawings illustrating habit of 11 plant species under investigation.

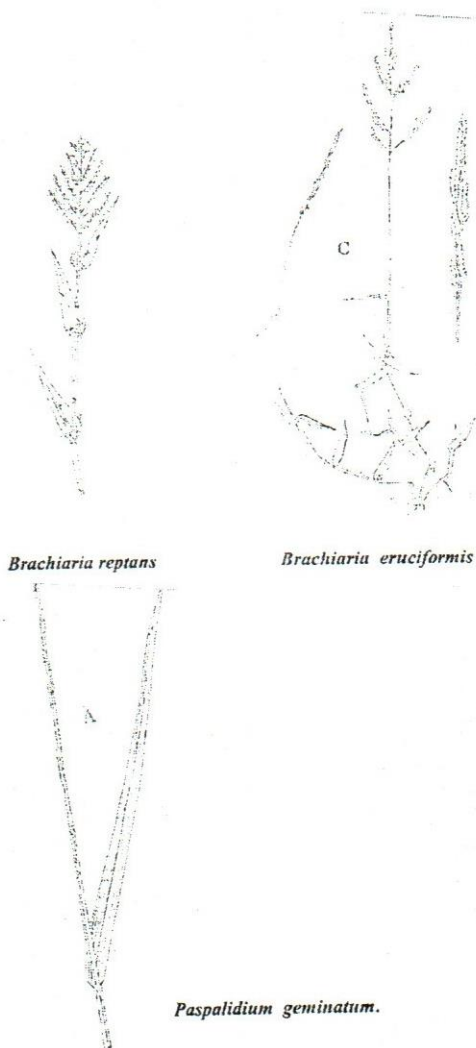
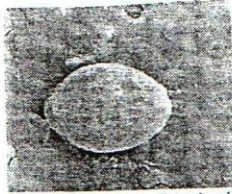
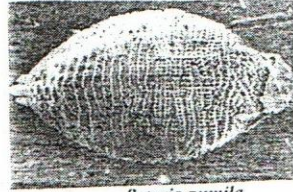


Fig. (1 cont.): Drawings illustrating habit of 11 plant species under investigation.

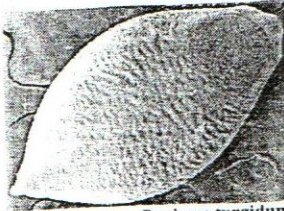




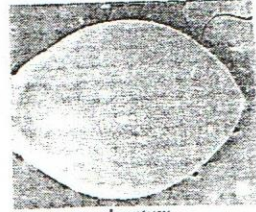
*Setaria viridis*



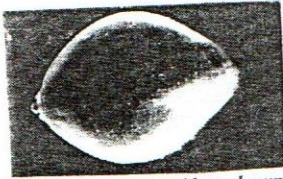
*Setaria pumila*



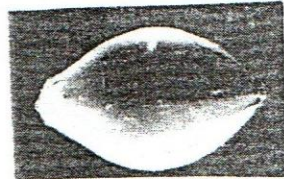
*Panicum turgidum*



*Panicum coloratum*

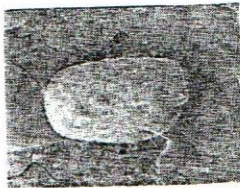


*Echinochloa colonum*

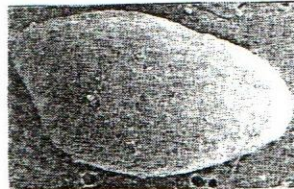


*Echinochloa crusgalli*

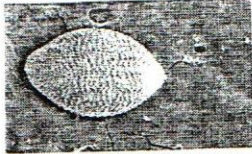
Plate (1): Grain shapes and sizes of the studied species as shown by SEM (X=60).



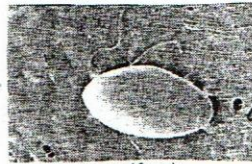
*Cenchrus ciliaris*



*Cenchrus echinatus*



*Brachiaria reptans*



*Brachiaria eruciformis*



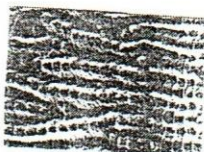
*Paspalidium geminatum*

Plate (1 cont.): Grain shapes and sizes of the studied species as shown by SEM (X=60).



(X= 1000)

*Setaria viridis*



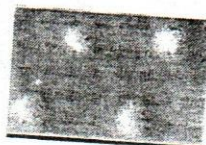
(X= 100)

*Setaria pumila*



(X= 250)

*Panicum turgidum*



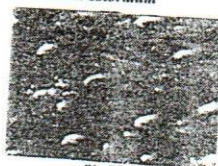
(X= 2500)

*Panicum coloratum*



(X= 750)

*Echinochloa colonum*



(X= 750)

*Echinochloa crusgalli*

Plate (2): Grain surface patterns of the studied species as shown by SEM.



(X= 1500)

*Cenchrus ciliaris*



(X= 1600)

*Cenchrus echinatus*



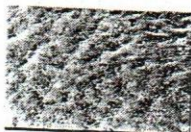
(X= 370)

*Brachiaria reptans*



(X= 7000)

*Brachiaria eruciformis*



(X= 1000)

*Paspalidium geminatum*

Plate (2 cont.): Grain surface patterns of the studied species as shown by SEM.

## 1) Vegetative features

### A- The Stem

The stem characters studied for the present species included; stem duration, position, texture, branching, thickness, shape and internode status. It could be noticed that all of the studied taxa have an erect stem, glabrous and branched at lower part of the plant, except *Paspalidium geminatum*, where its stem was kneed at base and branched at lower and upper parts of the plant. Most of the studied species are annual, except both species of *Panicum* and *C.ciliaris* and *Paspalidium geminatum*, where they are perennial. Both species of genus *Panicum* (*P.trgidum* and *P.coloratum*) and *Paspalidium geminatum* have thick stem, while the rest of species have thin stem. The compressed stem shape was observed in *S.pumila* and genus *Cenchrus* (*C.ciliaris* and *C.echinatus*), while the cylindrical stem shape was the common in the other studied species.

The hollow internode was noticed in species of each genus of *Panicum* (*P.turgidum* and *P.coloratum*), *Brachiaria* (*B.reptans* and *B.eruciformis*), in addition to *Paspalidium geminatum*. Solid internode was in the rest of species.

### B- The Leaf

The leaf length of all the studied taxa was less than 15 cm and the leaf width was ranging between 5-7 mm. Leaf blade edge and texture were glabrous in the species of each genus of *Panicum* and *Echinochloa*, in addition to *Paspalidium geminatum*, while this edge and texture were hairy in the rest of the studied species. Ligule was present in all species, except it was replaced by rim of hair in *C.echinatus* and *B.reptans* and was absent in both species of genus *Echinochloa*.

### C- The Sheath

Sheath shape was compressed in the species of each genus of *Echinochloa* and *Cenchrus*, in addition to *Paspalidium geminatum*, while cylindrical shape was found in other species. The glabrous sheath texture was observed in both *Echinochloa* species and *Paspalidium geminatum*, in contrary, it was hairy in the rest of species. It is worthy to notice that the un-membranous sheath edge was found in species represent the genera of; *Setaria*, *Panicum* and *Echinochloa*, while the membranous edge of sheath was present in the species of genera; *Cenchrus* and *Brachiaria*, in addition to *Paspalidium geminatum*.

## 2- Reproductive features

### A- The Inflorescence

#### AA- Type:

Three different inflorescence types have been observed being as follows:

- 1- Open panicle: as in both species of genus *Panicum*.
- 2- Closed panicle: as in the species of each genus of *Setaria* and *Echinochloa*.
- 3- Spike: as in the species of genera *Cenchrus* and *Brachiaria*, and *Paspalidium geminatum*.

#### AB- Spikelet:

The following spikelet characters were recorded:

**1-Arrangement:**

- Regular: as in the species represent genera *Panicum*, *Echinochloa* and *Brachiaria*, in addition to *Paspalidium geminatum*.
- Non- regular: as in the species of each genus of *Setaria* and *Cenchrus*.

**2-Rachis texture:**

- Glabrous: as in the species of genera; *Panicum*, *Echinochloa* and *Brachiaria*.
- Hairy: as in the species of genera *Setaria* and *Cenchrus*, in addition to *Paspalidium geminatum*.

**3-Number of flower:**

- Single flower: was noticed in species of genera *Panicum* and *Brachiaria* plus *Paspalidium geminatum*.
- Two flowers: were present in the species of genera *Setaria* and *Echinochloa*.
- Three to five flowers: as found only in genus *Cenchrus*.

**AC- Glume, Lemma and Awn:**

It could be noticed that in, all the studied species, the glume and lemma texture were glabrous, except in *C.ciliaris*, where they were hairy. Awn was absent in all species, except it was present in the abovementioned species.

**AD- Grain:**

The following characters were recorded and illustrated on the grains representing the studied species by using the Scanning Electron Microscopy (SEM) (Plates 1&2) :

**1- Shape:**

The elliptic or broadly elliptic grain shape were observed in species belong to genera; *Setaria*, *Panicum*, *Echinochloa* and *Brachiaria*. While, the species of genus *Cenchrus*; *C.ciliaris* with rectangular-oblong grain shape and *C.echiratus* with ovoid-shaped. Lanculaite-ovoid shape of grain was found in *Paspalidium geminatum*.

**2- Texture:**

All the studied species have smooth grain surface.

**3- Colour:**

It could be recognized the following grain colour among the grains of the studied species.

- Grey: as found in *S.viridis* and both species of genus *Echinochloa*.
- Creamy / brownish: as found in both species of genus *Cenchrus*.
- Creamy / dark brown: as in the species of genus *Panicum* and *Paspalidium geminatum*.
- Creamy / black: as found in species of genus *Brachiaria*.

**4-Size:**

After fixing the magnification power at  $x = 60$ , this character was recorded by measuring the length and width of the grain:

- Small grains: which have lengths ranging between 1.4 to 1.8 mm and widths ranging between 0.6 to 1.3 mm as in the species belong to

genus *Brachiaria* and *Echinochloa*, in addition to *S.viridis* and *Paspalidium geminatum*.

- Medium grains: which have 2.8 mm length and 0.9 mm width as in *C.ciliaris*.
- Large grains: which have lengths ranging between 2.4 to 3.0 mm and 2.0 mm width as found in species of genus *Panicum* and the individual species; *S.pumila* and *C.echinatus*.

#### **5-Grain surface sculptures appearance:**

It is worthy to notice from Table (2) that the grain surface sculptures appearance had wide range of variation not only between genera, but also among the species of the same genus as follows:

- Reticulate-Foveate: as in *B.reptans*.
- Reticulate-Verruculate: as in *Paspalidium geminatum*.
- Favulariate-Striate: as in *S.pumila*.
- Favulariate-Foveate: as in *Echinochloa crusgalli*.
- Foveate: as in *C.echinatus*.
- Rugose: as in *C.ciliaris*.
- Rugose-Scalariform: as in *P.turgidum*.
- Rugose-Puntate: as in *E.colonum*.
- Ruminant: as in *S.viridis*.
- Pusticulate: as in *P.coloratum*.
- Glebulate: as in *B.eruciformis*.

Tantawy and Rabie, (2000) used the grain colour in their classification, which was in accordance with the present results. Meanwhile, Hussein, (1995) reported that the grain colour considered a taxonomic character with a limited value for its possible fluctuation in the same grain when looking to it from different duration. Karakus, (1996) supported that when stated that the grain colour depends largely on the metabolic activities within the plant and on the environmental conditions. Thompson, (1992) stated that the grain size is subjected to ecological and physiological variations and is unreliable for either identification or differentiation. Voughan, (1968) suggested that the structure of the mature grain, especially grain surface was considered the most taxonomic useful information. This was in harmony with what Coner, (1976) stated. Who considered the grains are the most strongly inherited part of the plant and the taxonomic significance could relate to the environmental selections. Yeh and Kakuma, (1990) studied the grain features (shape, colour, patterns and size) and suggested that these characters lead to better criteria for identification and support the taxonomic positions of taxa. Hussein, (1995), by using Scanning Electron Microscope, agreed with the present investigation on the epidermis features, and reported that grain characters widely used on keys to distinguish taxa and handled by many botanists.

#### **II) Numerical analysis**

The phenogram (Fig.2), created by using the different morphological characters of the studied species (10 specimens of each species) and the grain surface features, had the highest average taxonomic similarity value of 1.14. At this level, the studied species split into two major groups. The first group, which was distinguished at level 1.00, included species of genera

*Brachiaria* (*B.reptans* and *B.eruciformis*) at level 0.18, and *Cenchrus* (*C.ciliaris* and *C.echinatus*) at level 0.71 and *Paspalidium geminatum* at level 1.00.

The second group was divided into two sub-groups at level 1.09. One sub-group distinguished at level 0.40, which included both species of genus *Echinochloa* (*E.colonum* and *E.crusgalli*) at level 0.4. The other sub-group included species of genera *Panicum* (*P.turgidum* and *P.coloratum*) at level 0.19 and *Setaria* (*S.pumila* at level 0.32 *S.viridis* at level 0.50).

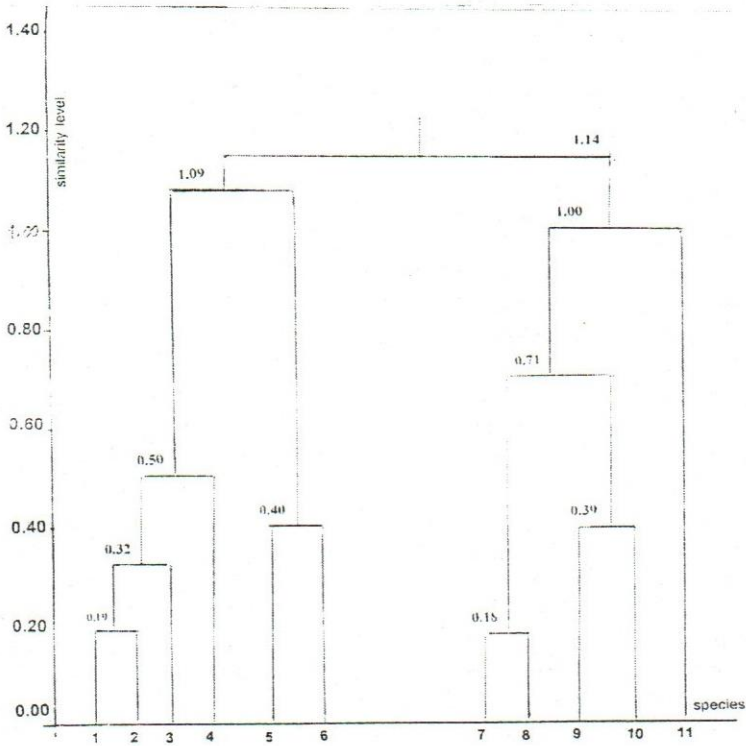


Fig. (2): Dendrogram of eleven Poaceae species based on similarity matrix using Single Linkage Clustering analysis technique.  
 Key: 1- *S. viridis* 2- *S.pumila* 3- *P.turgidum* 4- *P.coloratum*  
 5- *E.colonum* 6- *E.crusgalli* 7- *C.ciliaris* 8- *C.echinatus*  
 9- *B.reptans* 10- *B. eruciformis* 11- *Paspalidium geminatum*.

From the phenogram also, it could be noticed that all the specimens represented the species of genus *Panicum* were joined together early in one cluster at low similarity level (0.19). Far a way, the same occurred with the species of genus *Brachiaria*, where all specimens represented its species were linked in cluster at low level of 0.18.

Back again to the cluster included *Panicum* and *Setaria*. At level 1.09, this cluster joined the pre-formed cluster included species belong to genus *Echinochloa*. The earlier formed cluster of *Brachiaria* remaining unlinked with other cluster till the similarity level at 0.71, wherethe cluster of both species of genus *Cenchrus* which linked at level 0.39 joined it, followed by the cluster included *Paspalidium geminatum* at level 1.00.

Finally, all the clusters; one had both species of genera *Panicum* and *Setaria*; the other included species of genus *Echinochloa* and the third cluster included both species of genera *Brachiaria*, *Cenchrus* and *Paspalidium geminatum*, were linked together in one large cluster at the highest level of similarity at 1.14 due to all species belong to Poaceae.

The present numerical analysis results were in agreement with those obtained by Khattab (2002) on some *Vicia* species and Youssef *et al.* (2003) on some species of Poaceae.

Based on all the studied morphological and grain surface features carried out on the present species, the following key was proposed to differentiate between them.

A- Inflorescence spike

b- Awn present, lemma hairy.....*Cenchrus ciliaris*

bb- Awn absent, lemma glabrous

c- Stem kneed at base, perennial.....*Paspalidium geminatum*

cc- Stem erect, annual

d-Sheath compressed, foveate epidermis appearance...*C.echinatus*

dd- Sheath cylindrical, varied epidermis appearance

e- Ligule present, glebulate epidermis appearance, .. *B.eruciformis*

ee- Ligule replaced by rim of hair, Reticulate foveate epidermis appearance..... *B.reptans*

AA- Inflorescence panicle

f- Internode solid, closed panicle

g-Stem compressed.....*S.pumi*

gg- Stem cylindrical

h- Leaf blade smooth, ligule present .....*S.viridis*

hh- Leaf blade hairy, ligule absent,

i- Epidermis appearance rugose punctate .....*E.colonum*

ii- Epidermis appearance favulariate-foveate ....*E.crusgalli*

ff- Internode hollow, open panicle

j- Epidermis appearance rugose scalariform ...*P.turgidum*

jj-Epidermis appearance pusticulate .....*P.coloratum*

**Conclusion**

The results obtained from studying the morphological and grain surface features, in addition to the numerical analysis could be concluded as follows:

- the species of genus *Setaria* (*S.pumila* and *S.viridis*), *Panicum* (*P.turgidum* and *P.coloratum*) were more closely related to each other,
- also, the species represent genus *Echinochloa* (*E. colonum* and *E. crusgalli*) were close, firstly to each other, then to the cluster included species of *Panicum* and *Setaria*,

- the species of genus *Cenchrus* (*C.echinatus* and *C. Ciliaris*) were similar to each other in most studied characters and linked, firstly with the cluster included species of genus *Brachiaria*,
- *Paspalidium geminatum* has morphological and grain surface features quite similar to species of genera *Cenchrus* and *Brachiaria* and varied from the other studied species, which led it to link with the above genera at late similarity level,
- grain surface sculptures appearance and shape are considered the most diagnostic taxonomic characters to differentiate among the studied species,
- and there are eleven features of the grain surface sculptures were observed by using SEM.

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## دراسات مقارنة مورفولوجية وفوق مجهرية على حبوب بعض أنواع الفصيلة النجيلية.

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أجريت دراسة للعلاقات التصنيفية بين أحد عشر نوعاً نباتياً من الفصيلة النجيلية وكانت الانواع تمثل ستة أجناس وهي:

*Setaria viridis* (Poiret) Roemer & Schultes

ذيل القط - ذيل الفأر

*Setaria pumila* (L.),

دفرة

*Panicum turgidum* Forssk,

نجيل فارسي

*Panicum coloratum* L.,

نجيل مداد

*Echinochloa colonum* (L.) Link.,

أبو ركة - حشيش الارانب

*Echinochloa crusgalli* (L.) P.Beauv.,

الذنبية

*Cenchrus ciliaris* L.,

رجل الغراب - شوكة

*Cenchrus echinatus* Vahl.,

*Brachiaria reptans* (L.) Gardner et Hubb.,

*Brachiaria eruciformis* (Sibth & Srm.) Griseb.

*Paspalidium geminatum* (Forssk.) Stapf.

حشيش مداد

ويهدف هذا البحث الى معرفة العلاقات التصنيفية بين الانواع (الوحدات التصنيفية) تحت الدراسة باستخدام الصفات المورفولوجية وخصائص سطح الحبوب (٢٩ صفة) للانواع تحت الدراسة باستخدام المجهر الماسح الالكتروني والتحليل العنقودي العدي لتحويل تلك الصفات.

أوضحت نتائج الوصف المورفولوجي للانواع تحت الدراسة التي أن الانواع التابعة لجنس *Panicum* (P. *turgidum* and P. *coloratum*) كانا الأكثر تشابها لبعضهما أولاً ثم للانواع من جنس *Setaria*.

كذلك الحال بالنسبة للانواع التابعة لجنس *Echinochloa* (*E. colonum* and *E. crusgalli*) كانتا أكثر تشابها أولاً مع الانواع التابعة لجنس *Panicum* and *Setaria*. وقد لوحظ تشابه النوع التابع لجنس *Cenchrus* مع الانواع من جنس *Brachiaria* والنوع *Paspalidium geminatum*.

تعتبر الصفات المظهرية لسطح الحبوب وكذلك شكل الحبوب من أهم الصفات التصنيفية للفرقة بين الانواع تحت الدراسة. وقد لوحظ باستخدام المجهر الالكتروني الماسح أن هناك أحد عشر شكلاً مختلفاً لسطح الحبوب لتلك الانواع.

وقد أظهر التحليل العنقودي العدي المستخدم أنه عند أعلى مستوى تشابه ١,١٤ أن الانواع تحت الدراسة انقسمت الى مجموعتين رئيسيتين: واحدة اشتملت على الانواع من أجناس *Brachiaria*, *Echinochloa* and *Paspalidium* والآخرى اشتملت على الانواع من أجناس *Panicum* and *Setaria*.

هذا وقد تم اقتراح مفتاح على أساس الصفات المورفولوجية وكذلك الصفات المظهرية للحبوب والمسح السطحي لها.