

FEATURES OF SEEDS AND THEIR ULTRASTRUCTURE SURFACE VARIATIONS IN SOME TAXA OF GENUS *Vicia* (FABACEAE).

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ABSTRACT

The morphological seed characters and seed testa structure variation of some taxa under 3 different sections of genus *Vicia* were studied. Scanning Electron Microscope (SEM) was used to clarify the seed testa variation patterns among the studied taxa. These taxa are; *V.faba* var. *minor*, *V.faba* var. *equina*, *V.johannis* var. *procumbens*, *V.hyaeniscyamus*, *V.bithynica* (section *Faba*); *V.sativa* var. *sativa* (section *Vicia*) and *V.peregrina* and *V.mollis* (section *Peregrina*).

Results of seed morphology and the structure of testa by SEM show that both varieties of *V. faba* are more close to each other than to any taxa of other studied sections, by sharing many characters, *i.e.*, seed colour and shape; papillae arrangement, size, density and apex shape; hilum groove colour, colour of center strip of hilum and most of hilum measurements. The three other taxa of section *Faba*; *V. johannis* var. *procumbens*, *V. hyaeniscyamus* and *V. bithynica*, represent similarity in some studied seed characters, *i.e.*, seed shape; papillae arrangement, apex shape, size, density, number of papillae per unit and presence of wax and hour-glass cells on papillae apex.

The results reveal also that both taxa of section *Peregrina* are similar to each other in many characters, *i.e.*, seed colour, shape and measurements; papillae arrangement, size, apex shape and absence of wax and hour-glass cells on papillae apex and colour of center strip of hilum, in addition to the other hilum measurements, *i.e.* length, width, shape and wavy edge of hilum groove. *V. sativa* var. *sativa* was medium in its character measurements, hence it is sharing the species of section *Peregrina* in some characters (seed colour, and shape; papillae arrangement, apex shape, size and absence of wax and hour-glass cells on papillae apex; hilum shape and colour of center strip of hilum) and the species of section *Faba* in other characters (papillae arrangement, density and absence of wax on papillae apex; hilum shape, colour and wideness of center strip of hilum).

INTRODUCTION

The Fabaceae seeds have been described in details by Corner (1976), who stated that the testa develops from the outer integument of the ovule after fertilization, the next layer is the pair of cotyledons. The most characteristic features of the Fabaceae seeds are their testa and hilum structure. He studied the morphological characters of seeds of *Vicia* species and stated that some of these characters, *i.e.*, seed shape (spherical, compressed and oblong); seed sutures (biconcave and biconvex); seed luster (shiny and dull); seed colour and measurements.

Hassan (1997) studied the spermoderm pattern of *Vicia* taxa and noticed that the most common shape is papillae, which varied among the taxa of the genus *Vicia*, *i.e.*, the shape is troughs and crests in the cultivated

taxon; broad bean (*V. faba*), while this shape is sea anemone-like in *V. peregrina* and *V. sativa* var. *sativa*. The arrangement of papillae was in regular rows as in last two taxa. The acute to obtuse papillae apex was observed in *V. peregrina*, while it was round to truncate in *V. sativa* var. *sativa*.

Gunn (1970) and Lersten and Gunn (1982) studied the hilum groove of *Vicia* taxa and they found five shapes; circumlinear (hilum length more than 50-70% of seed circumference and more than 10 times longer than wide), linear (hilum less than 50% and 5-7 times longer than wide), oblong (the hilum less than 50% and from 2-5 times longer than wide), wedge-shaped (like oblong but margins converge to the lens) and oval (the hilum less than 20% and less than 2 times longer than wide). These characters are quantitative rather than qualitative and are difficult to determine.

Kaur and Pal (1989) stated that the oblong hilum was in *V. faba*, while it was linear to oblong in *V. peregrina*.

The recent investigation was carried out to clarify the relationships among some taxa from different sections of genus *Vicia* by studying the morphological features of seeds, in addition to the seed coat characters (testa and hilum) by using Scanning Electron Microscope technique (SEM).

MATERIALS AND METHODS

The current investigation was performed on season 2000. Seeds of 8 taxa belonging to 3 different sections of genus *Vicia* namely; *V. faba* L. var. *minor* Beck, *V. faba* L. var. *equine* Pers., *V. johannis* Tamamschjan var. *procumbens* Schäfer; *V. hyaeniscyamus* Mout. and *V. bithynica* L. (section *Faba*); *V. sativa* var. *sativa* (Doethes) Asch. & Graebner (section *Vicia*) and *V. peregrina* L. and *V. mollis* Boiss. & Hausskn (section *Peregrina*).

Dry seeds of these taxa were provided by the Gene Bank of Biology Department, Southampton University, U.K. and the morphological characters were recorded. These characters were; seed colour, shape, size; hilum groove colour, colour of center strip of hilum and lens position. For studying the other seed characters as seed surfaces and hilum, the method described by Trivedi *et al.*, (1978) was applied. Air dried seeds of each taxon were taken and glued on the stubs of the Scanning Electron Microscope, then coated with gold and left for a few minutes then examined by the Scanning Electron Microscope at National Research Center, Giza.

RESULTS AND DISCUSSION

1- Seed morphology

The morphological and SEM seed characters are tabulated in Table (1) and illustrated in Figures (1 to 6) as follows:

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A- Seed colour

Colour of seed testa varied not only from taxon to another, but also among different specimens of the same taxon. Within a particular taxon there may be specimens with many different testa colours, therefore, the seed colour described here is based on many seed samples of each taxon to recognize the common colour among them. The common testa colours are:

- Creamy with black, brown and sometimes gray mottling as in *V.bithynica* (Fig. 1).
- Dark brown or black as in *V.johannis* var.*procumbens* and *V.hyaeniscyamus* (Fig. 1).
- Black or dark brown testa as in *V. faba* var. *minor*, *V.faba* var.*equina* and some in *V.hyaeniscyamus* (Fig. 1).
- Brown or reddish-brown as in some seed samples of *V.faba* var.*minor* (Fig. 1) and in *V.mollis* (Fig. 2).
- Yellow-brown testa in *V.sativa* var.*sativa* and *V.peregrina* (Fig. 2).

B- Seed Shape

There are four different shapes of seed among the studied taxa, which are as follows:

- Spherical and slightly compressed shape as in *V.bithynica*, or spherical in *V.johannis* var.*procumbens* and *V.hyaeniscyamus*. (Fig.1).
- Oblong shape in both varieties of *V.faba*; var.*minor* and var.*equina* (Fig. 1).
- Rounded shape in *V.sativa* var.*sativa* (Fig. 2).
- Round and slightly compressed shape in *V.peregrina* and *V.mollis* (Fig. 2).

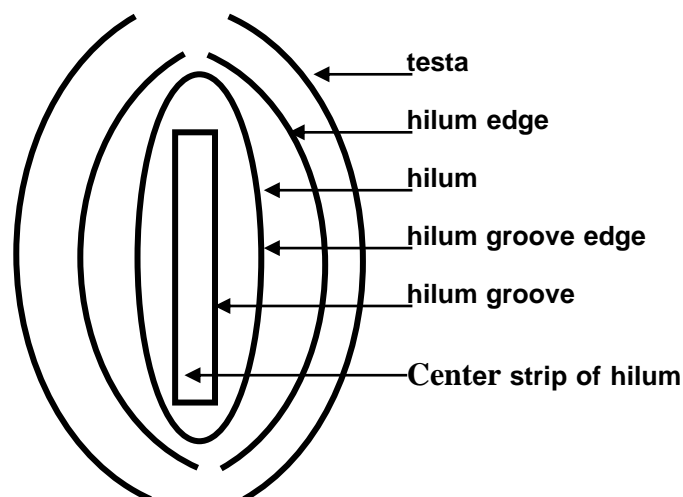
C- Seed Size

This character was recorded, in the wild studied taxa, by measuring the seed length (parallel to hilum) and seed width (from the center of hilum to the opposite side of the seed). While in *V.faba* var.*minor* and var.*equina* the seed length was from the center of hilum to the opposite side of the seed and seed width was parallel to the hilum. From the above record, It could be recognized the following seed sizes (as an average of 20 examined seeds):

- From 14-17x7-13 mm in *V.faba* var.*equina* and from 9-14x7-10 mm in *V.faba* var.*minor* (Fig. 1).
- From 4-10x2-8 mm in *V.johannis* var.*procumbens* and in *V.hyaeniscyamus* (Fig. 1).
- From 3-7x2-4 mm as smallest seed size in *V.bithynica* (Fig. 1).
- From 2-6x1-3 mm in *V.sativa* var.*sativa* (Fig. 2).
- From 4-8x2-5 mm in *V.peregrina* and from 5-8x3-5 mm in *V.mollis* (Fig. 2).

D- Hilum groove colour

The external structure of hilum is shown in the diagram below:



The hilum groove colour was either black or dark brown in both varieties of *V.faba* and *V.hyaeniscyamus* (Fig. 1), *V.peregrina* and *V.mollis* (Fig. 2). The red-brown colour of hilum groove was in *V.johannis* and the beige one was in *V.bithynica* (Fig. 1). The white or pale beige colour of hilum groove was detected in *V.satva* var.*satva* (Fig. 2).

E- Colour of center strip of hilum

It could be recognized that both varieties of *V.faba* have white center strip of hilum, while it was red brown or beige in *V.hyaeniscyamus*, *V.johannis* var.*procumbens*, *V.bithynica* (Fig. 1), *V.satva* var.*satva*, *V.peregrina* and *V.mollis* (Fig. 2).

F- Lens position

Boissier (1872) used the lens position as a primary diagnostic character within genus *Vicia*. The distance between lens to the center of hilum is not sharply distinct and ranging from 0.8-4 mm among all the studied species.

The previous results completely agreed with those obtained by Corner (1976), Muratova (1931), Cubero (1982), Cubero and Suso (1981), Higgins *et al.* (1981) and Schäfer (1973).

2- SEM results

I- Papillae arrangement

Papillae were arranged in regular rows in *V.johannis* var.*procumbens*, *V. hyaeniscyamus* (Fig. 4) and *V.bithynica* (Fig. 5) from section *Faba* and *V. peregrina* and *V.mollis* from section *Peregrina* (Fig. 6), while they were irregular in *V.faba* var.*minor*, *V.faba* var.*equina* from section *Faba* (Fig. 3) and *V.satva* var.*satva* from section *Vicia* (Fig. 5).

II- Papillae apex suture

It is worthy to notice that the papillae apex was covered with wax in *V. johannis* var.*procumbens*, *V.hyaeniscyamus* (Fig. 4) and *V.bithynica* (Fig. 5). The uncovered apex was observed in the other two taxa of section *Faba*; *V.faba* var.*minor* and *V.faba* var.*equina* (Fig. 3), in addition to the three taxa of the other two sections; *V.sativa* var.*sativa* in section *Vicia* (Fig. 5), and *V.peregrina* and *V.mollis* in section *Vicia* (Fig. 6).

C- Shape of papillae apex

The rounded shape of papillae apex was observed in all taxa of section *Faba* (Figs. 3, 4 and 6) and *V.sativa* var.*sativa* (Fig. 5), while the acute shape of papillae apex was in *V.peregrina* and *V.mollis* (Fig. 6).

IV- Papillae density (Compactness)

The papillae were less compacted in *V.faba* var.*minor* and *V.faba* var.*equina* from section *Faba* (Fig. 3), as well as in *V.sativa* var.*sativa* from section *Vicia* (Fig. 5). The medium compactness of papillae was observed in the other three taxa of section *Faba*; *V.johannis* var.*procumbens*, *V.hyaeniscyamus* (Fig. 4) and *V.bithynica* (Fig. 5). Both taxa of section *Vicia*; *V.peregrina* and *V.mollis* have more compactness papillae on their surfaces (Fig. 6).

V- Papillae size

It could be recognized that the large size of papillae was in both varieties of *V.faba* (Fig. 3), whereas, it was medium papillae size in *V.johannis* var. *procumbens*, *V.hyaeniscyamus* (Fig. 4) and *V.bithynica* (Fig. 5). The smallest thin papillae were observed in *V.sativa* var.*sativa* (Fig. 5) and *V.peregrina* and *V.mollis* from section *Peregrina* (Fig. 6).

VI- Hour-glass cells on papillae apex

The presence of hour-glass cells on papillae apex was obvious in *V.johannis* var.*procumbens*, *V.hyaeniscyamus* (Fig. 4) and *V.bithynica* (Fig. 5), while these cells were absent in the other taxa; *V.faba* var.*minor* and var. *equina* (Fig. 3), *V.sativa* var.*sativa* (Fig. 5) and both taxa of section *Peregrina*; *V.peregrina* and *V.mollis* (Fig. 6).

VII- Number of papillae per unit

It is worthy to notice that, the number of papillae per unit (100 μ) was varied according to the size and compactness of papillae. The greatest number of papillae was recorded in both taxa of section *Peregrina*, which their papillae sizes were small. This number was 31 in *V.mollis* and 26 in *V.peregrina* (Fig. 6). The smallest number of papillae per unit was observed in *V.faba* var.*minor* (6) and *V.faba* var.*equina* (8), where their papillae sizes were large (Fig. 3). *V.johannis* var.*procumbens*, *V.hyaeniscyamus*, *V.bithynica* and *V.sativa* var.*sativa* have medium number of papillae; 15,13, 14 and 15, respectively (Figs. 4 and 5).

H- Hilum length and width

There is a linear relationship between the hilum length and width, in other words, if the length increase, the width will increase too and the *vice versa*, The maximum values for average length and width of hilum were in both varieties of *V.faba*; var. *minor* (4.5 x 1.5 mm) and var. *equina* (3.2 x 1.3 mm) (Fig. 3). While, the minimum values for average length and width of hilum were in *V.sativa* var. *sativa*; 1.1 x 0.6 mm (Fig. 5). The medium measurements were recorded in *V.johannis* var. *procumbens* (2.8 x 1.2 mm) and *V.hyaeniscyamus* (2.6 x 1.1 mm) (Fig. 4). *V.bithynica*, *V.peregrina* and *V.mollis* have quite similar measurements of average length and width of *V.sativa* var. *sativa*, where these measurements were 1.2 x 0.8, 1.2 x 0.8 and 1.3 x 0.9 mm, respectively (Figs. 5 and 6).

I- Hilum shape

There are 4 types of hilum shape among the studied taxa as follows: oblong-elliptical hilum shape in both varieties of *V.faba* (Fig. 3); oval hilum shape in *V.johannis* var. *procumbens* and *V.hyaeniscyamus* (Fig. 4); the oblong hilum shape was in *V.sativa* var. *sativa* and the oblong to linear shape of hilum was in *V.bithynica* (Fig. 5) and *V.peregrina* and *V.mollis* (Fig. 6).

J- Symmetry of hilum groove

Hilum groove is an area restricted between the center strip of hilum and hilum groove edge as in the above diagram. It noticed that the hilum groove is symmetrical in all the studied taxa (Figs. 3, 4, 5 and 6).

K- Hilum groove length and width

The highest values for length and width of hilum groove were found in both *V.faba* var. *minor* (2.5 x 1.6 mm) and *V.faba* var. *equina* (2.4 x 1.4 mm) as shown in (Fig. 3). The lowest values of length and width were in *V.mollis* (0.50 x 0.02 mm) as in (Fig. 6). *V.johannis* var. *procumbens* and *V.hyaeniscyamus* have medium values of length and width of hilum groove, where they are 1.70 x 0.80 mm and 1.80 x 0.90 mm (Fig. 4), respectively. The length and width values of hilum groove of *V.bithynica*, *V.sativa* var. *sativa* and *V.peregrina* were slightly higher than that of *V.mollis* (Table 1 and Figs. 5 and 6).

L- Hilum groove edge

There are two patterns of hilum groove edge among the studied taxa; entire edge was noticed in both varieties of *V.faba*, *V.johannis* var. *procumbens* and *V.sativa* var. *sativa* (Figs. 3, 4 and 5), or wavy edge of hilum groove as in *V.hyaeniscyamus*, *V.bithynica*, *V.peregrina* and *V.mollis* (Figs. 4, 5 and 6).

M- Center strip of hilum

The widest center strip of hilum was noticed in *V.faba* var. *minor* and *V.faba* var. *equina* (Fig. 3), while in *V.johannis* var. *procumbens*, *V.*

hyaeniscyamus and *V.sativa* var.*sativa*, the center strip of hilum was slightly narrower than both *V.faba* varieties (Figs. 4 and 5). On the contrary, the narrowest center strip of hilum was observed in *V.bithynica*, *V.peregrina* and *V.mollis* (Figs. 5 and 6).

Most of the Scanning Electron Microscope results were in harmony with those obtained by Lersten and Gunn (1982) on *Vicia* sp.; Kaur and Pal (1989) on *V. sativa*; Hassan (1997) on *V. faba*, *V. sativa* and *V. peregrina*; Gunn (1970); Roti-Michelozzi and Serrato-Valenti (1981) and Sakr (2000) on *Vicia* species.

CONCLUSION

Both varieties of *V.faba* var.*minor* and *V.faba* var.*equina* are more close to each other than to any other species for sharing many characters, *i.e.* seed colour and shape; papillae arrangement, apex shape, size and density; hilum shape, length and width, colour of center strip of hilum and hilum groove colour. The other three taxa of section *Faba*; *V.johannis* var. *procumbens*, *V.hyaeniscyamus* and *V.bithynica* were sharing many of the studied characters, *i.e.* seed colour, shape and measurements; papillae arrangement, apex suture, shape, size and density and number of papillae per unit.

Both taxa of section *Peregrina*; *V.peregrina* and *V.mollis* are close to each other to be in the same section, due to their similar characteristics, *i.e.*, seed colour, shape, measurements; papillae arrangement, apex shape, size and number of papillae per unit; hilum shape, wideness and colour of center strip of hilum.

V.sativa var.*sativa* has some characters similar to the taxa of section *Peregrina*, *i.e.*, seed colour, shape; papillae size; colour of center strip of hilum and hilum shape, as well as some characters similar to species of section *Faba*, *i.e.* papillae arrangement, number of papillae per unit; wideness of center stripe of hilum and hilum groove edge. So its position in a separate section (*Vicia*) is acceptable.

Finally, the following key was designed to distinguish the studied taxa of genus *Vicia*:

- 1- Seed shape oblong, papillae arrangement irregular2
- Seed shape spherical or rounded, papillae arrangement vary.....3
- 2- Seed brown to reddish brown, 9-14 x 7-10 mm, papillae with rounded apex.....*V.faba* var.*minor*
- Seed black to dark brown, 14-17 x 7-13 mm, papillae with rounded flat apex.....*V.faba* var.*equina*
- 3- Papillae apex covered with wax, spherical seed shape 4
- Papillae apex uncovered with wax, rounded seed shape.5
- 4- Edge of hilum groove entire *V.johannis* var.*procumbens*
- Edge of hilum groove wavy.....6
- 5- Papillae apex rounded, wide center strip of hilum.... *V.sativa* var.*sativa*
- Papillae apex acute, narrow center strip of hilum.....7

- 6- Center strip of hilum wide.....*V.hyaeniscyamus*
- Center strip of hilum narrow.....*V.bithynica*
- 7- Number of papillae in 100µ more than 30, black colour of hilum groove.....*V.peregrina*
- Number of papillae in 100µ less than 30, dark brown colour of hilum groove.....*V.mollis*

REFERENCES

- Boissier, P. E., (1872). Flora Orientalis. Vol. 2. A. H. George, Geneva, Switzerland.
- Corner, E. J. H. (1976). The seeds of dicotyledons. Vol. 1. Cambridge, London: Cambridge University Press. p. 161-173.
- Cubero, J. I., (1982). Interspecific hybridization in *Vicia*. In: "Faba bean Improvement". [G. Hawtin and C. Webb Eds.] p. 91-108.
- Cubero, J. I. and M. J., Suso (1981). Primitive and modern Forms of *Vicia faba*. Kulturpflanze, 29. p. 137-145.
- Gunn, C. R., (1970). A key and diagrams for seeds of one hundred species of *Vicia* (Leguminosae). International Seed Testing Association. 35:773-790.
- Hassan, A. E. (1997). Comparative studies on some species of the genus *Vicia* L. Ph. D. Thesis, University of Suez Canal. Fac. of Agric. Agric. Bot. Depart: 134pp.
- Higgins, J.; J. L. Evans and P. J. Reed (1981). Classification of Western European Cultivars of *Vicia faba* L. National Institute of Agric. Botany Jor., 15:480-487.
- Kaur H. and A. Pal (1989). Structure, anatomy and spermoderm pattern of seeds in some *Vicia* species (Papilionoidae). Phytomorphology. 39 (4): 363-370.
- Lersten, N. R. and C. R., Gunn (1982). Testa characters in tribe Vicieae with notes about Abreae, Cicerae, and Trifolieae (Fabaceae), USDA. Tech. Bull. 1667: 1-40.
- Muratova, V. S., (1931). Common Beans (*V.faba* L.) Supplement 50, Bulletin of Genetics and Plant-breeding, Leningrad, p. 248-298.
- Roti-Michelozzi, G. and G., Serrato-Valenti (1981). Seed characteristics in Italian species of genus *Vicia* section *Eruum* and their diagnostic value. Seed Sci. and Technology. 14: 391-402.
- Sakr, M. M. (2000). Testa structure and identification of some *Vicia* species. Bull. Fac. of Agric., Cairo Univ., 51: 55-72.
- Schäfer, H. I. (1973). Zur taxonomic der *Vicia narbonensis* Gruppe. Kulturpflanze 21: 211-273.
- Trivedi, B. S.; C. D. Bagchi and U., Bajpai (1978). Spermoderm pattern in some taxa of Vicieae (Papilionoideae- Leguminosae). Phytomorphology. 28: 405-410.

صفات البذرة واختلافات سطحها الفوق مجهرية فى بعض الفئات التصنيفية من جنس الفول *Vicia* (الفصيلة البقولية).

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تم دراسة الصفات المورفولوجية للبذور وكذلك اختلافات تركيب القصرة لبعض الفئات التصنيفية التابعة لثلاثة قطاعات مختلفة من جنس *Vicia*. وقد استخدم المجهر الإلكتروني الماسح لإيضاح أنماط اختلافات قصر البذرة بين الفئات التصنيفية تحت الدراسة. وكانت تلك الفئات كما يلى:

V.faba var. *minor*, *V.faba* var. *equina*, *V.johannis* var. *procumbens*; *V.hyaeniscyamus* and *V.bithynica* (section *Faba*); *V.sativa* var. *sativa* (section *Vicia*) and *V.peregrina* and *V.mollis* (section *Peregrina*).

أظهرت نتائج الفحص المورفولوجى للبذور وكذلك تركيب القصرة باستخدام المجهر الإلكتروني الماسح إلى أن الصنفين التابعين للنوع *V. faba* كانا أكثر تقارباً لبعضهما البعض عن الفئات التصنيفية بالأقسام الأخرى وذلك نتيجة لاشتراكهما فى العديد من الصفات مثل: لون البذرة وشكلها - انتظام الحلمات على القصرة وحجمها ومدى كثافتها وشكل قمة الحلمة. كما تشابهت معظم القياسات الأخرى للسرة مثل لون حواف السرة - لون الأخدود المركزى للسرة وطول واتساع السرة. أظهرت الفئات التصنيفية الثلاثة الأخرى بقطاع *Faba* تشابهاً كبيراً فى معظم صفات البذرة المدروسة مثل لون وشكل وقياسات البذرة - انتظام الحلمات على القصرة وشكلها وحجمها وكثافتها وعددها وطبيعة قمة الحلمة.

كما أظهرت الفئات التصنيفية بقطاع *Peregrina* تماثل فى العديد من الصفات المورفولوجية مثل لون وشكل وقياسات البذرة - انتظام الحلمات على القصرة وعددها وحجمها وشكل قمة الحلمة - شكل السرة ولون واتساع الأخدود المركزى لها. توسط الصنف *V. sativa* فى صفاته من حيث التشابه لبعض صفات الفئات التصنيفية بقطاع *Peregrina* مثل لون وشكل البذرة - حجم الحلمات على القصرة - شكل السرة ولون الأخدود المركزى لها وكذلك تشابه لبعض صفات الفئات التصنيفية بقطاع *Faba* مثل انتظام الحلمات على القصرة وعددها - اتساع الأخدود المركزى للسرة وشكل حافة السرة.

