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MORPHOLOGICAL, STOMATAL AND SEED YIELD CHARACTERIZATION OF SOME CHICKPEA STOCKS

Sawsan M.A-B. Abou-Taleb[1], S.A. Shrief[2], Elham F.Gomaa[1] and D. S. Darwish [2]

1- Agric. Botany Dept., Fac. Agric., Cairo University, Giza, Egypt.

2- Agron. Dept., Fac. Agric., Cairo University, Giza, Egypt.

ABSTRACT

Two field trials were conducted during 2001/2002 & 2002/2003 seasons at the Research Station, Fac. Agric., Cairo University, Giza, to evaluate 10 chickpea genotypes. These genotypes comprised 7 introductions from ICARDA and 3 improved Egyptian cultivars. These genotypes belonged to the Kabuli type except cultivar Giza 88 (Desi type). The studies aimed to explore variation and relationship among these chickpea genotypes for morphological, stomatal and yield traits.

All the studied genotypes developed erect main stem. Five types of chickpea secondary branching were observed. These types were arised as basal, the lowermost third part, the basal half, along the whole main stem and basal and apical branching with the mid region free of secondary branches. Tertiary rather leafy branching was also noticed in all studied genotypes.

In Desi type, the flower corolla was purple in colour, whereas the Kabuli type possessed yellowish corolla.

Leaf epidermis of both Kabuli and Desi types possessed the anomocytic stomata. The stomatal densities and guard cell length varied between adaxial and abaxial leaf sides according to genotypes.

Stem and leaf epidermal cells of studied genotypes possessed the same kinds of glandular and nongiandular hairs. The bases of both kinds of trichomes were raised above the epidermal layer. Moreover, these bases were surrounded by epidermal cells in radiating-like arrangement.

Genotypic differences were detected among the tested chickpea stocks for flowering and maturity dates and yield traits. The environmental effects as seasons affected significantly most of studied chickpea traits. The stocks x seasons interaction were significant for all measured traits at both seasons except for main stem length, no. seeds/plant and seed index, which indicated that the investigated chickpea genotypes ranked differently from season to another.

In the second season the flowering and maturity were later by 30 and 7 days, respectively compared to first season. In addition to their relatively shorter plant height, higher numbers of pods and seeds, higher seed yield and lesser wilt diseases infection.

The range of maturity dates of studied genotypes combined over seasons was narrower (3 days) than detected for flowering (15 days). The number of internodes was negatively correlated with main stem length. The number of

internodes/main stem was positively significantly correlated with numbers of pods and seeds/plant but negatively significantly correlated with seed index. Another significant negative correlations occurred between seed index and each of pods/plant, seeded pods %, seeds/plant and seeds/pod. The wilt infected plants % varied from about 33.0 % for 7 out of 10 tested genotypes to 48.8 % for an exotic genotype. Such variation of wilt infection reflected in seed yield / ridge.

Final clustering analysis, formed three groups each comprised two genotypes and four ungrouped genotypes. The chickpea groups and ungrouped genotypes could be classified into three categories, i.e promising, non-promising and donor one. The promising stocks possessed most useful traits except few ones that may be transferred from donor stocks. The Egyptian varieties (G. 88, G. 531 and G.195) and other two introductions may be belonged to promising category. The non-promising category comprised one exotic stock (# 35). The donor group included three introductions that are distinctive in one or few characters. These genotypes may be used for lowering stomatal densities at both sides of the leaf in addition to heavy seed weight. In conclusion, some genotypes of the present chickpea collection offer good opportunity for improving this crop under various conditions by direct utilization or through proper breeding programs.

Key words: ***Chickpea, Genotypes, Morphology, Stomata, Yield, Cluster analysis.***

INTRODUCTION

Chickpea (*Cicer arietinum*) is one of the most important and of the first domesticated food legumes (van de Maesen 1987). Cultivated chickpeas are divided into two types: Kabuli which grows in the Mediterranean region and in Central and South America and Desi that grows in the Indian subcontinent and east Africa (Singh 1997). Numerous constraints, mainly lack of resistance to multiple biotic and abiotic stresses, facing chickpea production (Singh 1997).

Chickpea possesses abundant genetic variation for quantitative and qualitative traits (Muehlbauer and Singh 1987). Several efforts were conducted for exploring chickpea genetic variation for yield and yield components (Khattab *et al* 1990, Chander *et al* 2001, Nimbalkar and Harer 2001, Ghafoor *et al* 2003 and Abdalla *et al* 2003). Moreovere, Halila and Strange (1997), Rahhal *et al* (2000) and Yadava *et al* (2000) reported genotypic differences among chickpea genotypes for wilt and root rot diseases. Iqbal *et al* (2002) observed that chickpea cultivars varied for stomatal characteristics with lacking correlation between such attributes and blight resistance. The genetic variability among chickpea accessions were also detected using seed storage protein profile banding (Dasgupta and Singh 2003) and DNA-RAPD analyses (Iruela *et al* 2002).

The environmental factors had marked effects on performance that differed among studied characters (Nassif 2002 and Abdalla *et al* 2003). Chickpea heat unit requirement and phenological stages varied significantly between seasons, genotypes and their interaction (Ramteke *et al* 1996).

Cluster analysis of quantitative characters is used frequently for categorizing chickpea accessions into morphologically similar and presumably genetically similar groups (Halila and Strange 1997, Nimbalkar and Harer 2001, Abdalla *et al* 2003 and Ghafoor *et al* 2003). This analysis seemed to be an efficient procedure for extracting the structured relationships between accessions and provides a hierarchical classification of them. However, the association of clusters of agronomic traits and protein profile banding by SDS-PAGE generally varied (Dasgupta and Singh 2003). Cluster analysis of DNA-banding differentiated Kabuli and Desi types (Iruela *et al* 2002) but no clear relationship were detected between accessions and geographical origin like that found for morphological characters.

The relationship between morphological and stomatal traits along to yield components of different chickpea genotypes is lacking. Thus, the present studies aimed to explore variation among different introductions of chickpeas compared to some Egyptian improved varieties for these attributes.

MATERIALS AND METHODS

Two field trials were conducted during 2001/2002 & 2002/2003 seasons at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt to evaluate 10 chickpea genotypes comprised 7 introductions from ICARDA and 3 improved Egyptian varieties (Table 1). All of these lines traced back to different origins and belonged to the Kabuli type except variety Giza 88 (Desi type). The sowing dates were the med November in both seasons. A Randomized Complete Block Design was used with 3 replications. The experimental plot consisted of three ridges, 4 m long and 60 cm apart. The seeds were hand planted in hills spaced 10 cm apart at both sides of the ridge leading to 33 plants/m^2. Cultural practices were adopted according to recommendations.

Lost plants after seedling emergence were attributed to the infestation of wilt and root rot fungus. The dates of 50% flowering and 95% maturity as well as surviving plants were recorded on plot basis. However, individual plant characters were determined from a sample of 10 guarded plants randomly picked from each experimental plot. Seed yield of central ridge as per plot (2.4 m^2) and the number of harvested plants were recorded from the sum of individual plant sample plus the remainder plants per plot.

Table 1. Code, Source and type of studied chickpea stocks.

#	Code	Source	Type	#	Code	Source	Type
4	FLIP 94-70	ICARDA	Kabuli	35	FLIP 97-85c	ICARDA	Kabuli
10	FLIP 95-66	ICARDA	Kabuli	36	FLIP98-196c	ICARDA	Kabuli
12	FLIP 95-69	ICARDA	Kabuli	88	Giza 88	ARC, Egypt	Desi
14	FLIP 95-117	ICARDA	Kabuli	195	Giza 195	ARC, Egypt	Kabuli
34	FLIP 97-174c	ICARDA	Kabuli	531	Giza 531	ARC, Egypt	Kabuli

Data of each experiment were subjected to the regular analysis of variance of RCBD. The homogeneity tests indicated the validity of conducting the combined analysis of variance over seasons. The wilt infected plants percentages were transformed to arc sin before the statistical analysis and seed yield/ridge was adjusted using covariance analysis on the number of harvested plants.

After 100 days from sowing of second season, a leaflet of the fifth terminal fully expanded leaf of the tallest branch represented the studied genotypes was used for epidermal investigation at 10.00 o'clock am. This was operated by means of slides and special adhesive through copying adaxial as well as abaxial epidermis. Optical micrometers (square and linear) were used to record stomatal densities (number per mm^{-2}) and the length of guard cells, µm (GCL) in epidermal copies. For statistical analysis, three samples were used for stomatal densities and ten for GCL per genotype. For examination of stomata and trichomes, specimens representing the epidermal layer of internodes as well as leaflets were passed through various steps of whole mounting method (Johansen 1942), crystal violet and erthrocin stains were included.

The cluster analysis was performed using the Group Average Linkage Hierarichal method by the Genstat program.

RESULTS AND DISCUSSION

Morphplogical and anatomical features

Main stem and branching

All the studied chickpea genotypes (Kabuli and Desi types) developed erect main stem. Genotypes coded # 10, # 14 and # 34 possessed significantly the highest main stem length but # 4, # 36 and G.531 had the shortest one. The number of internodes/main stem was negatively significantly correlated with whole length of main stem (r= -0.67*). This

means that the tall of main stem chickpea plants was mainly due to the the length of its internode. As shown in Fig.(1), five types of main stem branching were observed for the studied chickpea genotypes. The first type was recorded in genotypes # 4 , # 10 and # 12 where the secondary branches arised only at the basal four internodes just above the soil surface, i.e. appeared as basal branching. In the second type the development of secondary branches extended up to the eighth node, i.e. branches localized in the lowermost third part of main stem as found in cultivar Giza 195. In the third type the secondary branches arised along the basal half of the main stem. Plants of Giza 88 and Giza 531 culrivars possessed this type of branching. The fourth type was recorded in two the two genotypes coded # 14 and # 34, where branching extended along the whole main stem. In the fifth type, the main stem exhibited basal and apical branching and the mid region was free of secondary branches as shown in the two genotypes coded # 35 and # 36. It's worthly to mention that tertiary rather leafy branching was also noticed in all studied genotypes.

Cubero (1987) reported the developing of quarternary branches in chickpea besides primary, secondary and tertiary ones. He estimated their erratic appearance and their unimportant role in the plant-life cycle attributing their developing mainly to rain fall within the growing season.

In Desi type (Cv. Giza 88), the flower corolla was purple in colour while the other genotypes (Kabuli type) possessed yellowish corolla. White flowers were reported by Singh (1997) for Kabuli type and purple for Desi one. Papilionaceous flowers born singly in axillary racemes in both Desi and Kabuli types. In this connection Cubero (1987) and Singh (1997) pointed out the presence of typically papilionaceous flowers borne singly on axillary raceme. However, twin flowers may also be found. Cubero (1987) reported that the rare forms with two flowers are used by breeders as possible source of yield increase. The phenomenon of twin flowers was considered as monogenic recessive trait according to Pundir *et al* (1988).

The number of leaflets per leaf ranged between 7-18, arranged on a rachis with small petiol. No major difference were detected between studied genotypes with respect to this character. Singh (1997) mentioned 11-13 leaflets per leaf in both types.

Stomata

Microscopic examination demonstrated that the leaf epidermal layer of both studied Kabuli and Desi types possessed the anomocytic stomata (Fig. 2), in which no detectable differences in shape were observed between

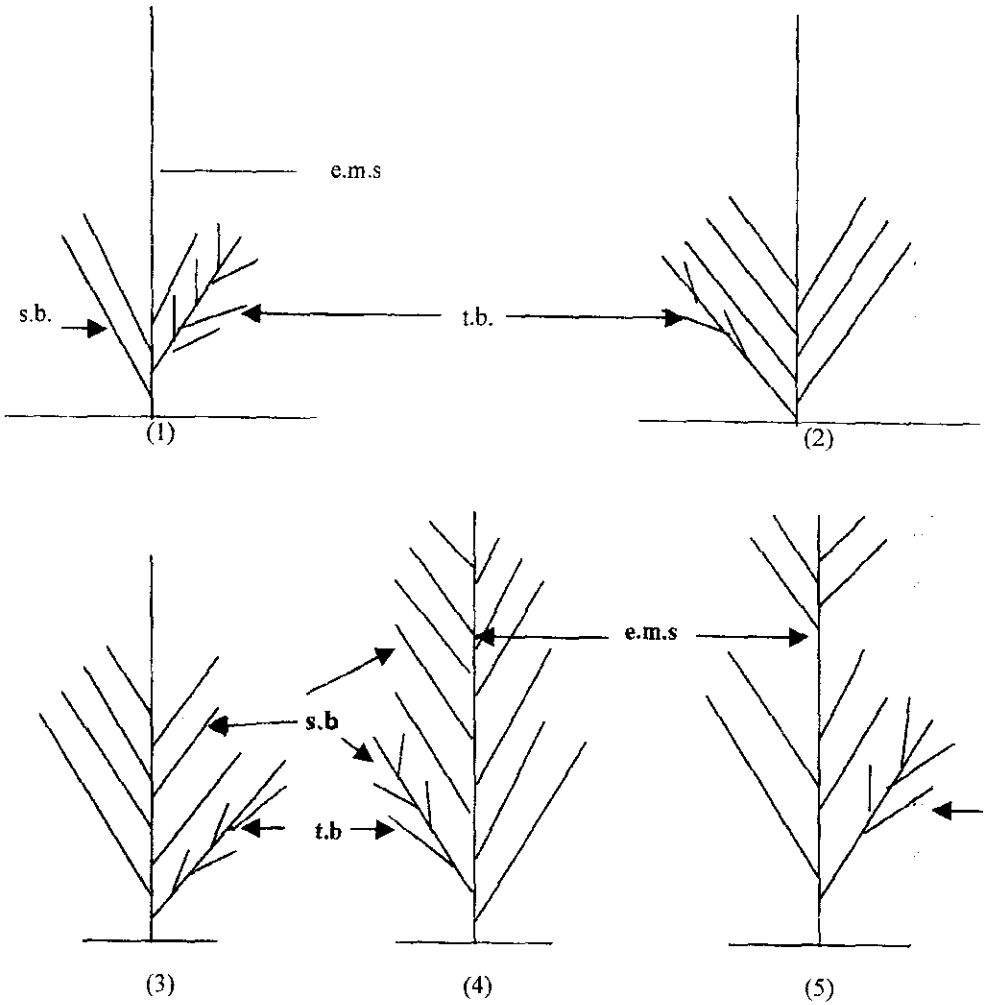


Fig.1. Branching patterns of different genotypes

1- #4, #10 & # 12 2-cv. Giza 195 3-cvs. Giza 88 & Giza 531

4- # 14 & # 34 5- # 35 & # 36.

(e.m.s. = erect main stem, s.b. = secondary branches and t.b. = tertiary branches).

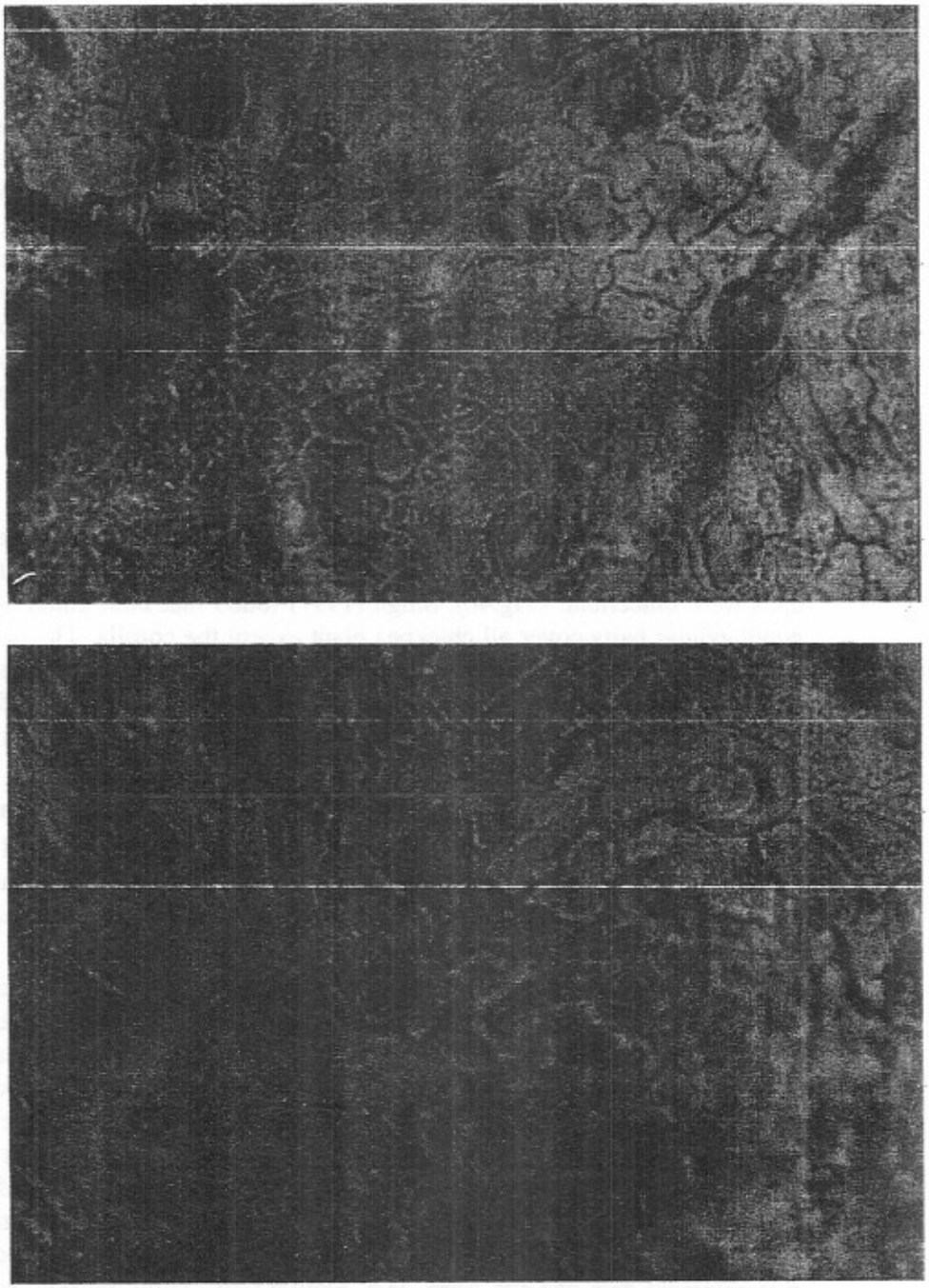


Fig.2. Showing the anomocytic type of stomata in chickpea leaf and bases of hairs surrounded by radiating-like epidermal cells

400 x

the few cells surrounding the stomata and the other ordinary epidermal cells. Anomocytic type was described formerly by Esau (1977) as the ranunculaceous type. The adaxial and abaxial leaf sides of genotype # 34 recorded the maximum stomatal density. The lower values for stomatal density on the adaxial leaf side was recorded in the genotypes # 36, Giza 531 # 4 and # 14, while the lower one on the abaxial surface was recorded by genotype # 4 (Table 3). The maximum GCL (μm) was recorded for the stomata of both adaxial & abaxial leaf surfaces of genotype Giza 531 (Fig.3a), whereas the lower values were recorded for the adaxial surface of genotypes # 36, # 14 and # 12. The lowest measurement of GCL (μm) was recorded for the abaxial leaf side of genotype # 36 (Table 3 and Fig.3b).

Trichomes

Stem and leaf epidermal cells of studied types possessed the same kindes of glandular and nonglandular hairs. The glandular hairs are with multicellular stalk ended by a multicellular head (Fig.4a). The nonglandular ones were unicellular (Fig.4b). Singh (1997) found that both glandular and nonglandular hairs cover all chickpea plant except the corolla. The bases of determined trichomes raised above the ordinary epidermal cells (Figs.4a & b). It's of interest to notice that the bases of trichomes are surrounded by epidermal cells in radiating-like arrangement (Fig.2). This radiate manner may act as supporting agent for these bases.

Significance of variances and influence of environmental conditions

Chickpea stocks varied significantly in both seasons and over seasons for all studied traits except for maturity date (in second seasons) and number of seeds/ pod (in 1st season). This means the existence of genotypic differences among the tested chickpea stocks for studied traits.

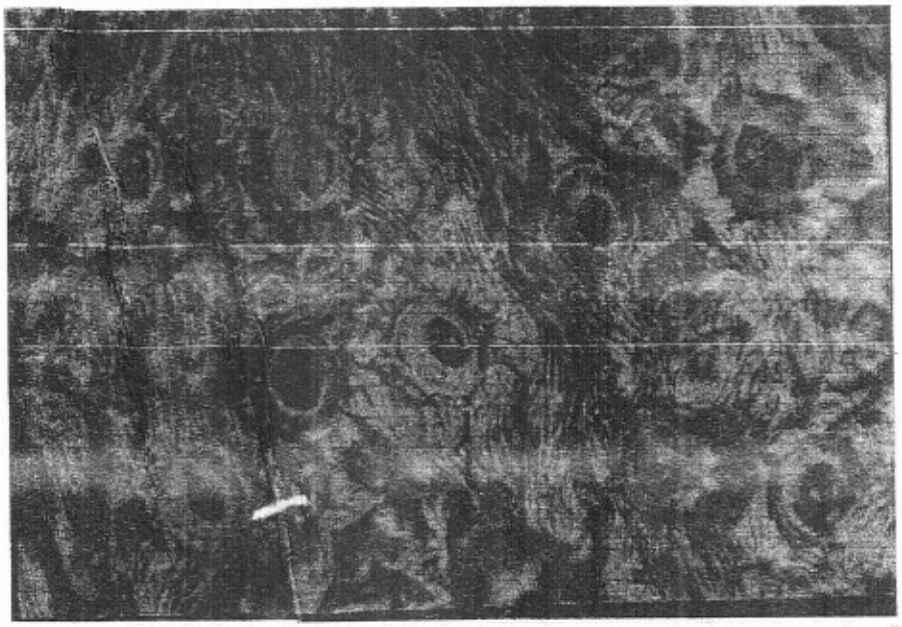
The effects of seasonal conditions on performance of chickpea were detected from combined analysis of variance. The environmental effects as seasons affected significantly the performance of chickpea traits (measured in both seasons) except no. internodes/ main stem, seeded pods %, no.seeds/pod and seed index. This indicates that chickpea traits are more sensitive to the changes of environmental conditions than the four latter ones. The variable effects of seasons may be attributed to the different temperatures and relative humidity prevailing at both seasons and the interaction of genotypes with the environmental conditions. The recorded meterological data of Giza Agro. Met. Station (No.15) during both seasons could be summarized as follows:

Table 3. Mean performance of studied chickpea stocks for flowering and maturity dates and seed yield attributes combined over 2001/2002 and 2002/2003 seasons and stomatal densities and guard cell lengthes (measured only at second season).

Stock	# 4	# 10	# 12	# 14	# 34	# 35	# 36	G.88	G.195	G.531
Flowering date, day	90.5 b	86.8 c	93.5 a	86.3 cd	85.5 cd	93.8 a	84.5 de	83.2 e	85.8 cd	85.2 cd
Maturity date, day	152.3 a-c	153.3 a	152.5 ab	152.0 a-c	152.3 a-c	153.3 a	151.0 c	151.8 bc	153.0 ab	152.5 ab
Main stem length, cm	48.5 cd	62.1 a	53.2 bc	63.9 a	64.9 a	55.4 b	44.7 d	54.1 bc	51.6 bc	48.9 cd
No. internodes/ m. s.	24.0 ab	21.6 d	23.6 a-c	22.5 b-d	19.0 e	21.7 cd	22.6 b-d	23.4 a-d	25.0 a	23.6 a-c
No. pods / plant	30.0 cd	28.8 c-e	31.5 c	35.4 b	26.9 de	25.1 ef	23.0 f	30.4 cd	40.0 a	37.4 ab
No. empty pods/plant	14.0 b	11.3 c	12.9 b	17.3 a	10.4 cd	9.4 de	10.2 cd	6.6 f	10.5 cd	8.7 e
Seeded pods %	54.6 d	62.4 bc	57.1 b-d	53.4 d	59.7 b-d	63.6 b	55.6 cd	78.0 a	75.1 a	76.0 a
No. seeds/ plant	18.0 cd	17.8 cd	22.1 bc	19.1 cd	17.7 cd	17.1 cd	14.7 d	24.5 b	30.4 a	24.3 b
Seeds/pod	0.60 b	0.61 b	0.71 ab	0.60 b	0.62 b	0.68 ab	0.61 b	0.81 a	0.73 ab	0.64 b
Seed index, g	25.5 b	30.6 a	25.4 b	21.4 c	30.6 a	21.8 c	31.3 a	18.7 d	14.3 e	21.4 c
Seed yield/plant, g	5.1 a	5.7 ab	6.2 a	4.2 cd	4.6 b-d	3.7 d	4.4 b-d	5.3 a-c	4.4 b-d	5.9 a
Seed yield/ridge, g	85.6 b	141.2 a	160.2 a	100.0 b	88.7 b	89.8 b	97.4 b	142.5 a	106.9 b	139.5 a
Infected plants %(actual)	48.8	33.3	32.1	32.3	37.2	36.2	43.6	34.5	47.4	34.0
Infected plants % (arc sin)	44.4 a	34.6 d	34.4 d	34.4 d	37.4 b-d	36.9 cd	41.1 a-c	35.7 cd	43.5 ab	35.4 cd
Stomatal density (ad)	176.7 d	251.7 bc	285.0 ab	171.7 d	315.0 a	258.3 bc	188.3 d	243.3 c	233.3 c	178.3 d
Stomatal density (ab)	216.7 d	246.7 cd	326.7 ab	250.0 cd	361.7 a	260.0 c	258.3 cd	315.0 b	323.3 ab	248.3 cd
GCL (ad), µm	26.2 bc	26.7 b	24.5 e	24.8 de	26.0 b-d	29.2 a	25.3 c-e	25.8 b-d	25.5 b-e	29.6 a
GCL (ab), µm	26.2 c	27.0 c	26.9 c	26.0 c	28.6 b	27.0 c	22.6 d	26.9 c	23.8 d	31.5 a

Means of stocks within a character followed by the same letter/s are not statistically different at 5 % level of probability.

a



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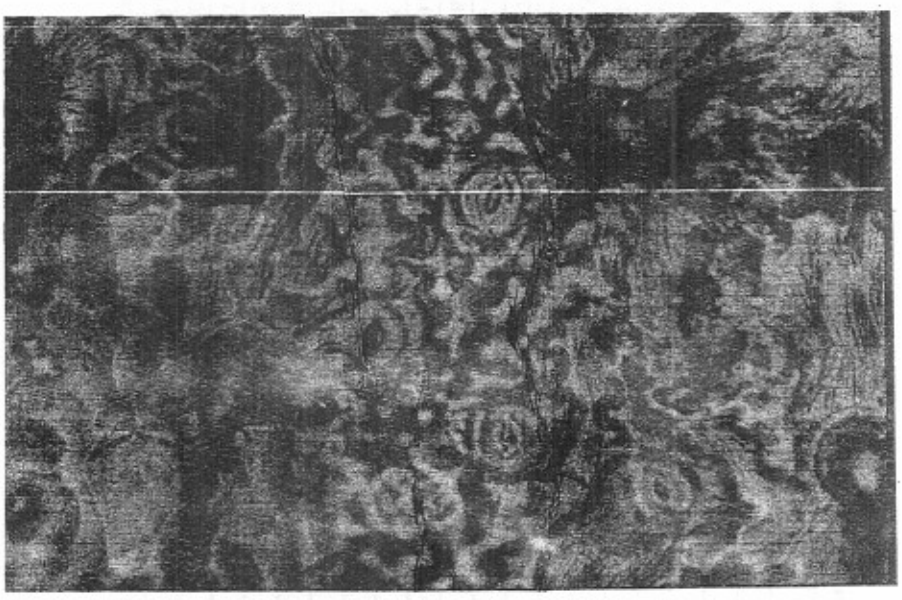

Fig.3. (a) Maximum GCL (μm) in abaxial leaf surface of genotype Giza 531.
(b) Minimum GCL (μm) in abaxial leaf surface of genotype (36).

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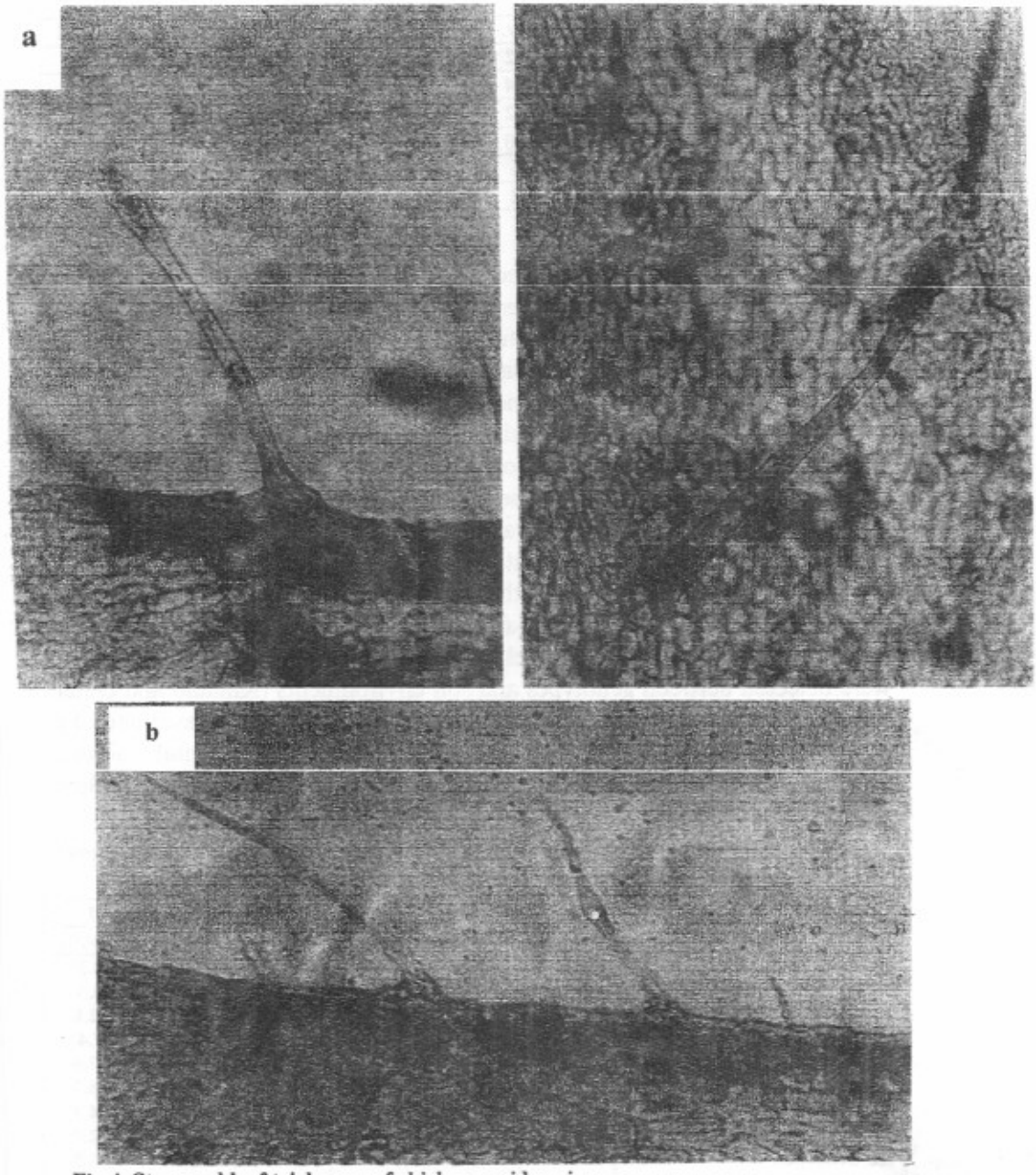

Fig.4. Stem and leaf trichomes of chickpea epidermis.

a- multicellular glandular hairs with multicellular head.

b- Unicellular nongalndular hairs

* notice raised bases of trichomes

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Measurement	Season	Nov.	Dec.	Jan.	Feb.	March	April
Average temperature °	1st season	14.2	13.2	11.8	11.1	14.6	14.0
	2nd season	13.4	13.6	14.8	14.5	8.6	15.4
Average RH	1st season	56.2	54.3	48	49	58.6	57.6
	2nd season	36.0	16.0	35.0	28.6	41.4	43.4
Evapotranspiration mm^{-1}	1st season	2.6	2.0	1.7	2.0	3.1	4.2
	2nd season	3.2	2.0	2.2	2.8	3.5	5.1

Climate of the second season was characterized by higher temperature particulary during December to Febrauary and lower relative humidity which reflected in higher transpiration than recorded in the first season. Such dominated conditions and other non-recorded climate parameters in the second season latened the flowering and maturity of the growing chickpea plants by 30 and 7 days, respectively compared to first season (Table 2). In addition to their relatively shorter height (by 5 cm), higher beared pods and seeds (more than 100%), higher seed yield (more than 100%) and lesser wilt diseases infections (mor than 50%). However, the number of empty pods/plant was parallelly increased to the increasing of pods/plant. It's worth to note that the stressed conditions recorded in the second season affected greatly the performance of tested genotypes as narrowing the coefficient of variability for all traits except no. of empty pods. Significant differences in chickpeas for reaction to wilt and root rot were detected between genotypes and soil environments (Khattab and Omar 1992). Chickpea yield losses due to root-rot / wilt infestation estimated by Khattab and Omar (1992) were attributed to environmental factors. Seedlings and root diseases were reported as factors contributing to low yield (Rahhal *et al* 2000).

Table 2 . Means of studied chickpea traits during both seasons and combined over seasons and coefficient of variability of different characters.

Traits	2001/2002		2002/2003		Combined	
	Mean	C.V.%	Mean	C.V.%	Mean	C.V.%
Flowering date, day	72.6	9.2	102.5	1.1	87.5	4.3
Maturity date, day	149.2	0.9	155.6	0.7	152.4	0.5
Main stem length, cm	57.5	15.7	52.0	10.1	54.7	12.6
No. internodes/ m. s.	22.7	9.9	22.6	9.1	22.7	7.4
No. pods / plant	20.7	24.2	41.0	22.0	30.8	17.6
No. empty pods/plant	6.8	23.6	15.4	35.3	11.1	26.9
Seeded pods %	65.5	14.1	61.6	18.8	63.6	14.9
No. seeds/ plant	13.5	24.7	27.7	28.8	20.6	22.9
No. Seeds/pod	0.7	13.2	0.7	15.6	0.7	10.5
Seed index, g	24.1	25.2	24.1	22.1	24.1	23.4
Seed yield/plant, g	3.8	26.2	6.1	19.7	5.0	16.4
Seed yield/ridge, g	72.0	26.5	158.4	28.4	115.2	24.0
Infected plants %(actual)	46.5	22.3	29.4	27.0	37.9	16.6
Infected plants %(arc sin)	42.9	14.3	32.6	15.0	37.8	10.1

The stocks x seasons interaction were significant for all measured traits at both seasons except for main stem length, no. seeds/plant and seed index. The significance of stocks x seasons interactions indicated that the investigated chickpea genotypes ranked differently from season to another.

Flowering, maturity and yield

Data in Table (3) revealed that the flowering dates of studied genotypes combined over seasons varied from after 83.2 days for G.88 to 93.8 days of genotype # 35. Genotype # 36 was also early in flowering as G.88 but # 12 was late flowering one as # 35. However, the range of investigated genotypes for maturity dates was narrower (3 days) than detected for flowering (15 days). The correlation between both dates didn't reach to the level of significance (r = 0.48 ns). This means that some of tested genotypes ranked differently for both dates. This may be due to the genotypic differences for flowering, pod filling and maturity durations. The main stem length of genotypes coded # 34, # 14 and # 10 were significantly higher than other genotypes particulary the shortest one (# 36) by about 20 cm. As previously mentioned, the number of internodes was negatively correlated with main stem length (r = -0.67 *), which means that taller genotypes possessed taller nodes and vice versa. The number of internodes/ main stem was positively significantly correlated with number of pods and seeds (r = 0.63 *) but negatively significantly correlated with seed index (r =- 0.65 *). This indicates that the increasing of main stem internode's number reflected in higher bearing of pods and seeds but such increasing of reproductive organs produced lighter seeds. Another significant negative correlations occurred between seed index and each of no.pods (r =-0.73 *), seeded pods % (r =-0.64*), no. seeds/plant (r =-0.82**) and no. seeds/pod (r =-0.64 *). This trend was true for gentypes G.195 and G.88, which produced the lighter seeds with higher numbers of pods and seeds/plant, No. seeds/pod and seeded pods %. The remainder genotypes showed variable interrelations performance for previously mentioned traits. The infected plants % varied from about the 33.0 % for 7 out of 10 tested genotypes (Table 3) to 48.8 % for genotype # 4. Such variation of wilt infection reflected in seed yield / ridge but not in yield per plant. This may be due to that the individual plant samlpes were restricted to survivng plants. This resulted in absence of significant correlations between the percentages of infection and other traits except seed yield/ ridge (r =0.64*).

Cluster analysis of chickpea genotypes

Cluster analysis of germplasm categorizing crop accessions is useful for describing the multi variation of a collection to facilitate efficiently the germplasm utilization in breeding programs. The group average linkage

hierarical procedure was used for clustering the investigated 10 chickpea genotypes. The dendrogram for clustering the studied 10 chickpea and the means of formed groups and ungrouped genotypes are presented in Fig. 5 and Table (4), respectively.

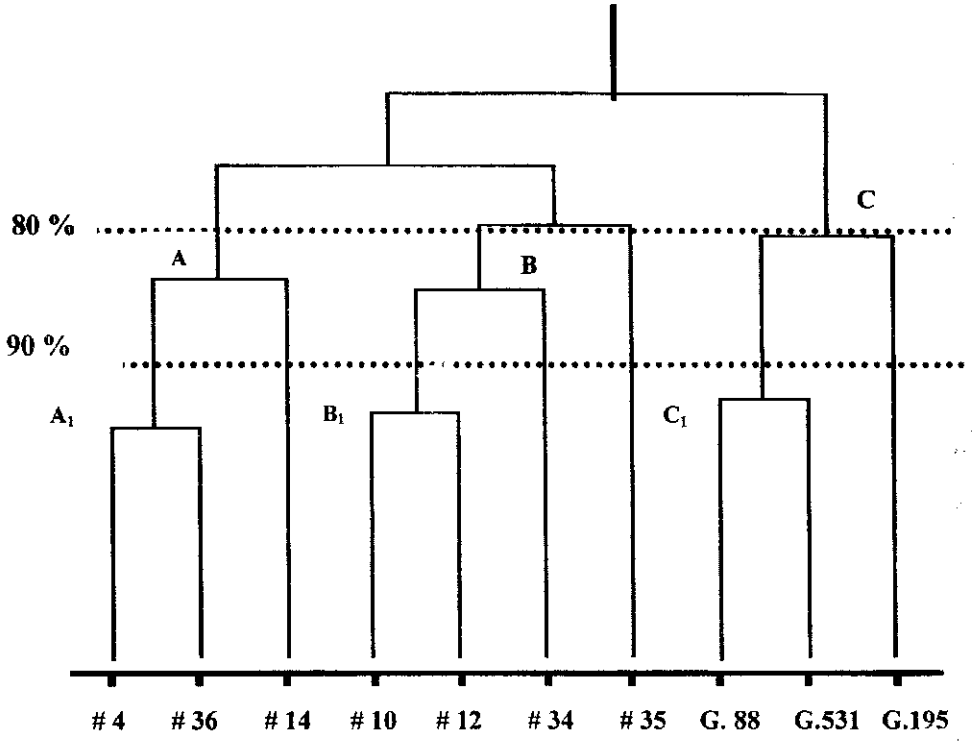

Fig. 5. Dendrogram from group average clustering of 10 chickpea genotypes

At the level of 80%, three groups: A, B and C in addition to one ungrouped stock were formed. The group A comprised 3 exotic kabuli chickpea stocks (# 4, # 36 and # 14). The group B also included three exotic genotypes: # 10, # 12 and # 34. However, the three Egyptian improved cultivars (Giza 88, Giza195, and Giza531) formed group C. Cluster C comprised earlist flowering plants that bearing highest numbers of pods and seeds with highest percentage of seeded pods that corresponded to lightest seed weight. Groups B and C produced better seed yield /ridge than group A. However, group B possessed tallest main stem, heaviest seed and lesser infected plants % with highest stomatal densities at both sides of the leaf. Genotype (# 35) may be ungrouped to either of the three formed clusters due to its latest flowering date and lesser number of pods and lower seed yield. Similar stomatal densities at both sides was observed in genotype # 35.

Table 4. Mean performance of group average cluster of 10 chickpea genotypes for studied traits.

80 %	90 %	No. Gen.	#	Flowering date, day	Maturity date, day	Main stem length, cm	No. pods / plant	Seeded pods %	No. seeds/ plant	Seed index, g	Seed yield/plant, g	Seed yield/ridge, g	Infected plants % (arc sin)	Stomatal density (ad)	Stomatal density (ab)	GCL (ad), µm	GCL (ab), µm
A		3		87.1	151.8	52.4	29.5	54.5	17.3	26.1	4.6	94.3	40.0	178.9	241.7	25.4	24.9
	A1	2		87.5	151.7	46.6	26.5	55.1	16.3	28.4	4.8	91.5	42.7	182.5	237.5	25.8	24.4
	1 ungrouped (#14)			86.3	152.0	63.9	35.4	53.4	19.1	21.4	4.2	100.0	34.4	171.7	250.0	24.8	26.0
B		3		88.6	152.7	60.0	29.0	59.7	19.2	28.9	5.5	130.0	35.5	283.9	311.7	25.7	27.5
	B1	2		90.2	152.9	57.6	30.1	59.8	20.0	28.0	6.0	150.7	34.5	268.4	286.7	25.6	26.9
	1 ungrouped (#34)			85.5	152.3	64.9	26.9	59.7	17.7	30.6	4.6	88.7	37.4	315.0	361.7	26.0	28.6
C		3		84.7	152.4	51.5	35.9	76.4	26.4	18.1	5.2	129.6	38.2	218.3	295.5	27.0	27.4
	C1	2		84.2	152.2	51.5	33.9	77.0	24.4	20.1	5.6	141.0	35.6	210.8	281.7	27.7	29.2
	1 ungrouped (G.195)			85.8	153.0	51.6	40.0	75.1	30.4	14.3	4.4	106.9	43.5	233.3	323.3	25.5	23.8
Ungrouped .#35				93.8	153.3	55.4	25.1	63.6	17.1	21.8	3.7	89.8	36.9	258.3	260.0	29.2	27.0

At 90% level, the genotype # 14 was splited from genotypes # 4 and # 36, which formed A1 sub-group. It may be that # 14 was ungrouped to A1 because its higher values of main stem length, pods and seeds number which reflected in lighter seed in addition to lower percentages of wilt infection and stomatal densities at both sides with taller GCL at adaxial surface. The division of genotype # 34 from # 10 and # 12 (sub group B 1) may be due to its earlier maturity , taller main stem with lower numbers of pods and seeds/plant that produced lower yield. Regarding the division of G.195 from the other two improved Egyptian varieties (G.88 and G.531 that formed sub group C 1) may be referred to its higher numbers of pods and seeds with lighter seed weight and increased infection percentage that resulted in lower seed productivity than C1.

The studied chickpea stocks could be classified into three categories, i.e promising, non-promising and donor one. The promising stocks possessed most useful traits except few ones that may be transferred from donor stocks (Abdalla *et al* 2003). The Egyptian varieties (G. 88, G. 531 and G.195) and exotic genotypes # 10 and # 12 may be considered the members of promising category. Genotypes # 10 # 12 that formed group B1 performed better for yield and its components as well as wilt resistance but may be only under non- stressed conditions. Their drought sensitivity could be referred to their highest numbers of stomata at both sides of the leaf which may permit higher water loss. On the other hand the cultivars formed C1 (G.88 and G.531) showed similar yield performance with advantages of higher seeded pods and lesser stomatal densities. The non-promising category comprised the stock # 35, which had many poor traits. The donor group included the sub-group A1(# 4 & # 36) and one ungrouped stock (# 34) that are distinctive in one or few characters. Genotypes # 4 and # 36 may be used for increasing low water loss because their lower stomatal densities at both sides of the leaf. However, using stock # 34 may be useful to heavy seed weight.

In conclusion, some genotypes of the present collection of chickpea offer good opportunity for improving this crop under various conditions by direct utilization or through proper breeding programs.

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الخصائص المورفولوجية والثغرية و المحصولية لبعض التراكيب الوراثية من الحمص

سوسن محمود ابو العلا ابو طالب[١] و سعيد عبد الرحمن شريف[٢] و الهام فوزى جمعه [١]

و درويش صالح درويش[٢]

١) قسم النبات الزراعى-كلية الزراعة-جامعة القاهرة

٢) قسم المحاصيل- كلية الزراعة – جامعة القاهرة.

نفذت تجربتان حقليتين فى محطة تجارب كلية الزراعة جامعة القاهرة بالجيزة خلال موسمى (٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣) لدراسة التباينات والعلاقات بين الصفات المورفولوجية والثغرية والمحصولية لعشرة تراكيب وراثية من الحمص. واشتملت تراكيب الحمص الوراثية على ٩ من الطرز الكابولى (سبعة منهم مستوردة من الايكاردا) والعاشر يتبع الطرز الديزى (الصنف المحسن جيزة ٨٨).

اوضحت الدراسة المورفولوجية ان كل التراكيب الوراثية المستخدمة ذات سوق قائمة. وكان هناك خمس طرز لتفرع الساق الاصلى الى افرع ثانوية. وهذه الطرز هى التفرع القاعدى-فوق سطح التربة مباشرة-وامتداد الافرع الثانوية الى ثلث الساق الاصلى وامتداد التفرع الى منتصف الساق الاصلى ووجود التفرع الثانوى على طول الساق الاصلى واخيراً خلو فقط الجزء الوسطى من الساق الاصلى من الافرع الثانوية. ولقد تميزت كل من التراكيب بوجود افرعاً ثالثية ذات اوراق.

تميز الطرز ديزى بوجود ازهار بنفسجية اللون بينما تميزت التراكيب الوراثية التابعة للطرز كابولى بوجود ازهار صفراء. وتميزت بشرة الورقة فى الطرزين ديزى ، كابولى بوجود ثغور من النوع anomocytic . كما اختلفت اعداد الثغور (مم٢)، وطول الخلايا الحارسة (بالميكرون) بالنسبة لسطحى الورقة وكذلك باختلاف التراكيب الوراثية.

واحتوت بشرة كل من الساق والورقة على نفس النمط من الشعيرات غدية كانت ام غير غدية ولوحظ ارتفاع مستوى قاعدة الشعيرات عن مستوى سطح البشرة العادى علاوة على تميز قواعد الشعيرات بوجود خلايا بشرة بشكل شعاعى محيطة بتلك القواعد.

اختلفت التراكيب الوراثية معنويا فى مواعيد التزهير والنضج علاوة على صفات الغلة. واثرت الاختلافات البيئية الموسمية معنوياً على غالبية الصفات المدروسة. كما كان تفاعل التراكيب الوراثية مع المواسم معنويا فى اداء كل الصفات ما عدا ارتفاع الساق الرئيسى، عدد بذور النبات ووزن البذرة (دليل البذرة) مما يوضح اختلافات ترتيب التراكيب الوراثية للصفات المعنوية بين موسم واخر.

تسببت الظروف المناخية السائدة فى الموسم الثانى فى تاخير موعدى التزهير والنضج بحوالى ٣٠ يوم و ٧ ايام على التوالى. هذا علاوة على انها تسببت فى قصر ارتفاع النباتات وزيادة اعداد القرون والبذور وغلة البذور بالاضافة الى قلة الاصابة بامراض الذبول.

كان مدى مواعيد نضج التراكيب الوراثية ضيقاً (٣ ايام) مقارناً بمواعيد تزهيرها (١٥ يوم). واظهرت اعداد سلاميات الساق الرئيسى ارتباطا سالبا مع طوله الا انها ارتبطت ايجابيا مع اعداد قرون وبذور النبات وسلبيا مع دليل البذور. وارتبط الاخير سلبيا مع كل من اعداد قرون وبذور النبات والنسبة المئوية للقرون الممتلئة وعدد بذور القرن. ولقد تباينت النسبة المئوية للنباتات المصابة بالذبول من حوالى ٣٣ % لسبعة تراكيب من العشرة الى ٤٨,٨ % لتركيب وراثى مستورد. وانعكس هذا التباين فى الاصابة بالذبول على غلة البذور.

اظهر التحليل العنقودى لصفات العشرة تراكيب وراثية من الحمص تجمعهم فى ثلاث مجموعات كل بها تركيبين بالاضافة الى ٤ تراكيب لم تؤهلها صفاتها الى الانتماء الى اى من المجموعات. وعلى العموم فان هذه المجموعات او التراكيب الغير منتمية لها يمكن تقسيمها الى ثلاث اقسام: واعدة وغير واعدة ومانحة. فالتراكيب الواعدة هى تلك التى تكون معظم خصائصها مرغوبة الا انه ينقصها عدد قليل من تلك الخصائص والتى قد يمكن نقلها من تلك التراكيب المانحة. واظهرالتحليل العنقودى ان الاصناف المصرية المحسنة بالاضافة الى تركيبين مستورديين يمكن اعتبارها المجموعة ذات الصفات الواعدة. اما التراكيب المانحة فاحتوت على ثلاثة من السلالات المستوردة تستحوذ خصائص فردية يمكن باستخدام طرق التربية والتهجين الملائمة نقلها الى الواعدة. فى حين ان تركيبة وراثية واحدة مستوردة اظهرت تدنياً فى غالبية خصائصها مما يمكن معه اعتبارها غير واعدة ولا مانحة. واجمالا يمكن الاستنتاج ان بعض التراكيب الوراثية التى اشتملت عليها الدراسة تقدم فرصة جيدة لتحسين خصائص الحمص سواء مباشرة او عن طريق ادخالها فى برامج تربية الحمص.