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Development and Performance of Some Onion (*Allium cepa* L.) Composites and Bi-parental Populations.

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Abstract

This study was conducted during the three successive seasons, 2016/ 2017, 2017/2018 and 2018/2019 at Giza Research Station, Onion Research Department, Field Crops Research Institute, Agriculture Research Center, Ministry of Agriculture. The objective of the study was evaluating eight onion genotypes and their crosses to forming new improved composites and bi-parental onion populations.

Eight onion genotypes included six exotic onion genotypes and two Egyptian onion cultivars. The eight genotypes were selected as wide diverse genotypes and representing a broad genetic base were used as parent seed to forming a new improved composites or bi-parental populations. The 8 parents and their 16 crosses were evaluated in two seasons in field experimental trial; RCBD with three replicates was used.

Genotypes (parents and their crosses) were significantly differed for all studied traits (number of days to maturity, total, marketable and culls yield ton/fed, percentage of total soluble solids %, dry matter content% and total weight loss%. The lowest number of days to maturity was observed for parents P_6, P_2 and P_3, for composites in C_6 and C_3 and for bi –parental in B_3, B_2 and B_6.

The highest total yield was recorded for parents by P_8 and P_7, for composites with C_4, C_7 and C_1 and for bi –parental with B_8, B_7 and B_4. The highest marketable yield was detected for parents with P_7, P_3 and P_6, for composites with C_4, C_1 and C_7 and for bi –parental with B_7 and B_4. The lowest culls yield was shown for parents with P_1, P_4 and P_3, for composites with C_3, C_6 and C_5 and for bi –parental with B_7, B_5 and B_2.

Highest values of TSS% were exhibited by parents P_5, P_7 and P_8, for composites C_8, C_6 and C_7, for bi–parental B_7, B_8 and B_1. The highest values of dry matter % were observed with parents P_5, P_7 and P_8, for composites C_8, C_7 and C_5 and for bi–parental B_7, B_1 and B_8.

The lowest values of total weight loss% were detected for parents, P_5 and P_1, for composites, C_5 and C_8, and for bi–parental, B_3, B_5 and B_7.

Keywords: Onion, genotypes, crossing, composites, bi-parental populations, maturity, yield and its components, storability

Introduction

Onion crop is one of the most important strategic crops in Egypt, whether for the farmer or for the national income. Egypt is self-sufficient in onions, in addition to being one of the top ten countries in the world in terms of total production and export. In 2019, the cultivated area of single onion winter crop in Egypt reached 190628 feddans and gave a production of 2.86 million tons, with an average productivity of 15 tons / feddan (1feddan = 4200 m^2)*.

The total exports amounted to 489 thousand tons, and it ranked fourth in the list of the top ten countries in total exports and total production of onions, and only preceded by the United States of America, India and then China, moreover onions ranked third in the ranking of agricultural exports for the same year, preceded by oranges and potatoes.

In spite of Egypt's participation in the world's onion exports reached 3%, which providing hard currency, this percentage is still low compared to China 30%, India 15% and the United States 10% (**FAO, 2019**), in addition to the increased demand for fresh or processed Egyptian onions from importing countries for Egyptian onions and the new markets that have been established and opened in front of the Egyptian onion.

There are some obstacles that affect the increase in production and export capacity of the onion crop, the most important one is the few numbers of improved cultivars. There are only four local Open-pollinated onion cultivars released: Giza 6 Mohsaan, Giza 20, Giza Red and Giza White.

Furthermore, some obstacles related to the nature of onion crop, as it is a biennial crop where one generation needs two years therefore development of adapted and improved onion cultivars is double time consuming than that the annual crops.

Crosses between widely divergent onion populations can produce hybrids which exceeded either parent in vigour. For example **Synnevag (1988)** crossed widely divergent onion populations Finnish multiplier onion with a Norwegian large-bulbed cultivar, and obtained hybrids that out yielded either parent and had a shorter growing period than the large-bulbed parent.

* Source: Central Administration of Agricultural Statics, Economic Affairs Sector, Ministry of Agriculture and Land Reclamation (2019).

Development of improved composite, synthetic or bi-parental populations is based on the selection of superior parents which has a broad genetic base and high divergent. Many worker studied the genetic diversity among their evaluated onion genotypes and classified their genotypes to narrow and wide. (**Dhotre, 2009; Patil, 1997; Ningadalli, 2006; Rashid *et al*. 2009; Ashry and Yaso, 2006; Abo-Dahab *et al*. 2018**).

Accordingly, the objectives of the study were development some onion composites and bi-parental populations and evaluating the parents and their crosses for onion yield, quality and storability characters.

Materials and Methods

3.1. Plant materials:

This study was conducted during the three successive seasons, 2016/2017, 2017/2018 and 2018/2019 at Giza Research Station, Onion Research Department, Field Crops Research Institute, Agriculture Research Center, Ministry of Agriculture.

Eight onion genotypes **(Table 1)** included six exotic onion genotypes and two Egyptian onion cultivars were selected as wide diverse genotypes as parent seed to forming a new improved composites or bi-parental populations .

Crossing technique: On November 2016, 32 onion bulbs were selected as a mother bulbs (parent-seed) represents each genotype. On December 2016 the 32 onion bulbs of each genotypes are divided into two groups.

Table 1. Name, Origin and method of developing the evaluated onion genotypes**.**

Cod	Genotype	Origin	Development method
P_1	Puss p.r.r.	USA	An advanced selection from introduced cv. Puss.p.rr.
P_2	Texas Early Grano	USA	Selection from an introduced Texas Early Grano cv. from USA.
P_3	Ori Yellow	Netherlands	Selection from cv. Ori Yellow that was introduced from Netherlands.
P_4	Beth Alpha	USA	Selection from cv. Beth Alpha that was introduced from USA
P_5	Extra Early Yalow Bermuda	USA	An advanced selection from introduced cv. Extra Early Yalow Bermuda
P_6	Oklahoma	USA	An advanced selection from introduced cv. Oklahoma
P_7	Giza 6 Mohassan	Egypt	Selection from cv. Giza 6 which selected from Upper Egypt strain (Saiedi).
P_8	Giza 20	Egypt	Selection from Egyptian Deltan types (Behairy) which collected from different provinces of delta regions.

The first technique of crossing included the first group (16 onion bulbs for each parent) these 16 selected mother bulbs were planted under insect proof cage, the cage which included 8 ridges, bulbs of each parent were arranged in eight ridges 4m long and the spacing between and within the ridges were (65 and 25 cm, respectively), and planted one time in each ridge with different position (Latin square). Honey bees was entered in the cage to complete inter-pollination.

On May 2017, seeds of the 16 mother bulbs for each parent were separately harvested and massed to form the first generation of composites (progeny of each parent, the pedigree of the eight progenies are listed in **Table2.**

Second crossing technique: The second group of bulbs (16 bulbs) which represents the 8 genotypes were dived into 4 groups, each one included two parents (genotypes) and planted in 4 isolates insect proof cages, each cage plot contained two ridges (one ridge for each parent) 4m long and the spacing between and within the ridge were (65 and 25 cm) respectively, each parent represented by 16 onion bulbs planted in one ridge and the second ridge was designated for the other parent.

Table 2. Pedigree of the 8 progeny formed by cross-pollination.

Population	Pedigree
Composite 1	$P_1(P_1\text{-}P_8)$
Composite 2	$P_2(P_1\text{-}P_8)$
Composite 3	$P_3(P_1\text{-}P_8)$
Composite 4	$P_4(P_1\text{-}P_8)$
Composite 5	$P_5(P_1\text{-}P_8)$
Composite 6	$P_6(P_1\text{-}P_8)$
Composite 7	$P_7(P_1\text{-}P_8)$
Composite 8	$P_8(P_1\text{-}P_8)$

P_1=Puss, pink root resistant. P_2=Texas Early Grano. P_3=Ori Yellow. P_4=Beth Alpha. P_5=Extra Early Yellow Bermuda (E.E.Y.B). P_6= Oklahoma. P_7=Giza 6 Mohssan. P_8= Giza20.

Table 3. The pedigree of the progenies of 8 bi-parental crosses.

Population	Pedigree
Bi-Parental 1	$P_1(P_1+P_7)$
Bi-Parental 7	$P_7(P_1+P_7)$
Bi-Parental 2	$P_2(P_2+P_3)$
Bi-Parental 3	P3(P2+P3)
Bi-Parental 4	P4(P4+P5)
Bi-Parental 5	P5(P4+P5)
Bi-Parental 6	P6(P6+P8)
Bi-Parental 8	P8(P6+P8)

P_1=Puss, pink root resistant. P_2=Texas Early Grano. P_3=Ori Yellow. P_4=Beth Alpha. P_5=Extra Early Yellow Bermuda (E.E.Y.B). P_6= Oklahoma. P_7=Giza 6 Mohssan. P_8= Giza20.

On April 2017, honey bees (broad) was entered in each cage to complete inter-pollination, on May 2017, seeds of the 16 mother bulbs (8 parents Seed) were harvested separately and massed to produce the first generation of bi-parental crosses **Table 3**. At the same time the eight parents are maintained in separately 8 isolate cages and using honey bees as pollinators.

Field Evaluation :

Seeds of the 24 genotypes {8 parents and 16 progenies (8 composites and 8 bi-parental populations)} were sowing on October 15, 2017 and October 24, 2018, and transplanted On December 28, 2017 and January 14, 2019 in both seasons, respectively for field trials evaluation. Randomized complete block design (RCBD) with three replicates was used; the experimental unit consisted of three ridges 3 m long and 65 cm apart. Seedlings were transplanted on both side of ridges 7-10 cm apart. All recommended agricultural practices were done.

Climatic conditions:

Data of monthly rain precipitation(mm), sun hours, maximum and minimum air temperature(c^0) and relative humidity(%) during the growing seasons at Giza Research Station (Giza province) are presented in **Table 4**.

Studied characters:

Number of days to maturity, total yield, marketable yield, culls yield, total soluble solids (TSS), dry matter content (DM) and total weight loss % were recorded.

Table 4. Monthly rain precipitation (mm); maximum and minimum air temperature, and relative humidity% at Giza Research Station (Giza province) during 2017/2018 and 2018/2019 growing seasons**.**

	Rain precipitation (mm/ Monthly)	Sun shine (Hours)	Air temperature (°C)				Relative humidity (%)		
Date	**Sum**	**Sum**	**Max.**	**Min.**	**Max.- Min.**	**Mean**	**Max.**	**Min.**	**Mean**
Dec. 2017	2.51	10.26	21.24	10.42	10.82	15.83	81.38	45.04	63.21
Jan. 2018	29.80	10.47	19.07	7.69	11.38	13.38	79.57	40.02	59.79
Feb. 2018	5.15	11.14	22.82	10.05	12.77	16.43	88.53	31.96	60.24
Mar. 2018	1.12	12.00	28.75	11.73	17.02	20.24	78.08	22.49	50.28
Apr. 2018	28.49	12.91	30.85	14.21	16.64	22.53	76.02	25.40	50.71
May 2018	0.15	13.67	35.63	19.16	16.47	27.39	72.33	23.70	48.02
Mean	**11.20**	**11.74**	**26.39**	**12.21**	**14.18**	**19.30**	**79.32**	**31.43**	**55.38**
Dec. 2018	9.15	10.25	20.46	9.68	10.78	15.07	85.25	43.62	64.43
Jan. 2019	2.21	10.46	18.85	6.17	12.68	12.51	71.66	31.25	51.46
Feb. 2019	5.50	11.13	21.02	7.49	13.53	14.26	85.30	30.22	57.76
Mar. 2019	10.98	11.99	23.71	9.05	14.67	16.38	80.63	30.09	55.36
Apr. 2019	1.88	12.90	28.21	12.38	15.83	20.30	75.27	24.29	49.78
May 2019	0.04	13.66	36.81	17.83	18.98	27.32	66.21	17.87	42.04
Mean	**4.96**	**11.73**	**24.84**	**10.43**	**14.41**	**17.64**	**77.39**	**29.56**	**53.47**

Source: Central Lab. for Agricultural Climate, Ministry of Agriculture and Land Reclamation.

Statistical analysis:

The first step for analysis variance is separate analysis of variance for each season for the 24 genotypes (8 parents and 16 crosses) was conducted according to **Steel and Torrie (1984)** and combined analysis of variance over the two seasons **(Table 5)** was performed according to **Gomez and Gomez**

(1984). Homogeneity test for error mean squares was done prior the combined analysis.

The means of genotypes were compared using Duncan's multiple range test **Waller and Duncan (1969)** at 0.05 probability level. Significance between overall mean of composites or Bi-parental and overall mean of parents was done using t test.

The second step of statistical analysis is partitioning the variance of genotypes into parents, crosses and parents vs crosses is performed therefore separate analysis of variance due to parents and crosses was performed as described in **Table 5.** Only data of combined analysis over the two seasons were presented and discussed.

Table 5. Mean squares for all traits in single season and combined over two seasons.

Source of variation	Degrees of freedom		Mean squares	Expectation of mean squares
	S	Comb.		
Rep (R)	(r-1)	-		
Season (S)	-	S-1		
Reps/seasons	-	S (r-1)		
Genotypes (G)	(g-1)	g-1	Mg	$\delta^2e + r\delta^2gs + rs\delta^2g$
Parents (P)	(p-1)	(p-1)	Mp	-
Crosses (C)	(c-1)	(c-1)	Mc	-
Parents vs. crosses	1	1	-	-
G ×S	-	(s-1)(g-1)	M_{gxs}	$\delta^2e + r\delta^2gs$
Error	(r-1) (g-1)	s (r-1)(g-1)	M_e	δ^2e
Total	rg-1	srg-1		

Where:
s, r and g: are seasons, replications and genotypes, respectively.
δ^2e, δ^2g and δ^2gs are error variance, genotype variance and genotype × environment variance, respectively.

Results and Discussion

Number of days to maturity:

Analysis of variance (**Table 6**) of genotypes (parents and their crosses) for number of days to maturity revealed significant differences for genotypes (parents and crosses), which indicated the presence of sufficient variability to select best parents and superior crosses to constitute better composites or bi-parental improved populations.

On the other hand parents vs. crosses effect was not significant although the significant superiority of overall mean of composites population or bi-parental populations than overall mean of all evaluated parents. Furthermore, the effect of genotypes × environments interaction was significant as a result of the influence of environmental factors such as annual rainfall, sun shine hours, minimum and maximum temperature and relative humidity fluctuations during growth and storage period as described in **Table 4** had affected on the performance of the evaluated genotypes on such trait. Onion maturity depend on the daily day night and temperature during maturity period.

Parents were significantly differed (**Table 7**), the highest number of days to maturity (late maturity) was displayed by P_7 (128.2 days), P_8 (126.2 days) and P_5 (125.3 days). Whereas, the least number of days (early-maturity) was recorded with P_6 (111.3days), P_2 (117.8 days) P_3 (118.0 days) and P_4 (118.8 days). The same trend were previously reported by **Hegazy and El- Sheekh (1999) and Sood (2000)** for onion maturity.

In the composites crosses (**Table 7**) the highest number of days to mature (late – mature) was detected with C_8 (127.5 days), C_7 (125.3 days) and C_1 (124.7 days). Meanwhile, the lowest values (early –mature) were showed in C_6 (118.0 days), C_3 (118.8 days) C_4 (119.8 days) and C_2 (119.8 days).

With respect to bi-parental crosses (**Table 7**) B_8 recorded the highest value (130.3 days) whereas it's reciprocal cross B_6 showed lower value (117.7 days) which suggest the effect of inbreeding and maternal effects on the performance of the cross and its reciprocal. Cross B_7 and its reciprocal cross B_1 showed higher value (129.5 and 126.5 days respectively). The lowest number of days to maturity (early – mature) was showed in B_3 and its reciprocal cross B_2 (116.2 and 116.3 days, respectively) fallowed by B_4 and its reciprocal cross B_5 (119.8 and 120.7 days, respectively).

Table 6. Mean squares from combined analysis of variance for evaluated genotypes (parents, crosses, and parents vs. crosses) tested over two seasons (2017/2018and 2018/2019) for number of days to maturity, total yield, marketable yield and culls yield.

S.O.V.	d.f	Number of days to maturity.	Total yield	Marketable yield	Culls Yield
Seasons (S)	1	3451.56*	0.85	21.54	13.87*
Rep/S	4	103.56	10.77	8.58	0.55*
Genotypes	23	143.70*	9.03*	8.58*	2.78*
Parents	7	193.43*	9.96*	6.80*	5.25*
Crosses	15	128.60*	9.07*	9.46*	1.69*
Parents vs. Crosses	1	22.22	2.00	7.79	1.89*
G × S	23	40.08*	3.40	3.96*	0.88*
Error	92	6.17	2.16	2.09	0.22

*significant at 0.05 level of probability.

Table 7. Performance of parents and their crosses evaluated in combined analysis for number of days to maturity, total yield, marketable yield and culls yield.

Character / Genotype	Number of days to 50% maturity	Total yield t/fed	Marketable yield t/fed	Culls Yield t/fed
Parents				
Puss, P.r. r (P_1)	124.5 de	16.19 d-h	15.82 c-i	0.370 d
Texas E.Grano (P_2)	117.8 gh	15.45 fgh	14.74 ghi	0.707 d
OriYellow(P_3)	118.0 gh	17.17 b-g	16.64 b-g	0.533 d
Beth Alpha (P_4)	118.8 gh	16.61c-h	16.22 b-h	0.395 d
E.E.Y.B(P_5)	125.3 cde	14.91 h	14.12 i	0.797 d
Oklahoma(P_6)	111.3 i	17.10 b-g	16.56 b-g	0.542 d
Giza.6.Mohassan(P_7)	128.2 abc	18.08 a-d	17.39 a-d	0.687 d
Giza 20 (P_8)	126.2 cd	18.78 ab	15.60 d-i	3.188 a
Mean	***121.26***	***16.79***	***15.89***	***0.900***
Crosses				
$P_1 \times (P_1\text{-}P_8)$ (C_1)	124.7 de	18.47 abc	17.86 ab	0.612 d
$P_2 \times (P_1\text{-}P_8)$ (C_2)	119.8 fg	17.11 b-g	16.48 b-h	0.632 d
$P_3 \times (P_1\text{-}P_8)$ (C_3)	118.8 gh	17.81 a-e	17.43 a-d	0.372 d
$P_4 \times (P_1\text{-}P_8)$ (C_4)	119.8 fg	19.21 a	18.68 a	0.535 d
$P_5 \times (P_1\text{-}P_8)$ (C_5)	122.7 ef	17.11 b-g	16.66 b-g	0.458 d
$P_6 \times (P_1\text{-}P_8)$ (C_6)	118.0 gh	17.48 a-f	17.06 a-e	0.423 d
$P_7 \times (P_1\text{-}P_8)$ (C_7)	125.3 cde	18.59 abc	17.77 abc	0.823 d
$P_8 \times (P_1\text{-}P_8)$ (C_8)	127.5 a-d	16.71 c-h	15.32 e-i	1.382 c
Composites mean	***122.08****	***17.81 ****	***17.16 ****	***0.650 ****
$P_1\times (P_1+P_7)$ (B_1)	126.5 bcd	14.90 h	14.50 hi	0.400 d
$P_7\times (P_7+P_1)$ (B_7)	129.5 ab	17.48 a-f	17.22 a-e	0.262 d
$P_2\times (P_2+P_3)$ (B_2)	116.3 h	15.93 e-h	15.54 d-i	0.387 d
$P_3\times (P_3+P_2)$ (B_3)	116.2 h	15.48 fgh	14.99 f-i	0.490 d
$P_4\times (P_4+P_5)$ (B_4)	119.8 fg	17.25 a-g	16.80 a-f	0.447 d
$P_5\times (P_5+P_4)$(B_5)	120.7 fg	16.04 e-h	15.76 d-i	0.275 d
$P_6\times (P_6+P_8)$ (B_6)	117.7 gh	15.39 gh	14.72 ghi	0.672 d
$P_8\times (P_8+P_6)$(B_8)	130.3 a	17.64 a-e	15.26 e-i	2.378 b
Bi-parentalsmean	***122.13****	***16.26 ****	***15.60 ****	***0.660 ****

[Z]Values followed by a letter in common are not significantly different from each other at P=0.05 according to Duncan's multiple range test.
*= significant at P:0.05,respectively

These results were previously supported by those obtained by **Hosfield *et al*. (1977 b); Andrasfalvy and Rozse (1983 a); Andrasfalvy and Rozse (1983 b); Abo-Dahab (2001).** They were made many crosses in onions and reported significant increases in the F_1s compared mid or better parent for onion maturity.

Total yield:

Mean squares due to various sources (genotypes, genotypes × seasons interaction, parents, crosses) for total yield are presented in **Table 6**. Results revealed that genotypes (parents and crosses) significantly differed. Genotypes × seasons interaction was not-significant which reflect their stability performance across seasons in spite of the fluctuations of the two seasons weather (**Table 4**). Furthermore, partitioning genotypes effect into parents and crosses showed significant differences among parents and crosses significantly differed. However, Parents vs. crosses effect was insignificant.

Performance of parents (**Table 7**) showed that parents P8 and P7 gave the highest total yield (18.78and 18.07 t/fed, respectively). On the other hand the lowest yield was showed in P_5 (14.91 t/fed), P_2 (15.45 t/fed) and P_1 (16.19t/fed). Similar findings were found by many investigators evaluated different onion cultivars and genotypes and detected significant variation among them **, Warid and El- Shafie (1976), Hegazy and El- Sheekh (1999), El-Aweel *et al*., (2000), Mohanty and Prusti (2001), and Abo-Dahab *et al*., (2018)** for bulb yield.

With regard to crosses performance (**Table 7**), the overall composites mean was significantly higher (17.81 t/fed) than parents overall mean (16.79 t/fed), C_4, C_7 and C_1 gave the highest values (19.21, 18.59and 18.47 t/fed respectively). While, the lowest values were recorded in C_8 (16.71 t/fed), C_5 (17.11 t/fed) and C_2 (17.11 t/fed).

Regarding to bi-parental cross populations (**Table 7**), the overall mean of bi-parental was significantly lower (16.26 t/fed) than overall mean of the evaluated parents (16.79 t/fed). However, B_8 gave the highest yield (17.64 t/fed) compared to its reciprocal cross B_6 (15.39 t/fed). Similarly cross B_7 gave the highest value (17.48 t/fed). Meanwhile, it's reciprocal cross B_1 produced lower value (14.90 t/fed). Also B_4 gave higher yield (17.25 t/fed) compared to B_5 that produced lower yield (16.04 t/fed). Cross B_2 and its reciprocal cross B_3 produced relatively the same yield (15.93 and 15.48 t/fed, respectively) These results were confirmed by those obtained by **Hosfield *et al*., (1977 a and b)**, **Andrasfalvy and Rozse (1983 a), Hanna (1987) , El-Sayed (1995), and Abo-Dahab (2001)** who found significant increases in yield of the F_1s compared to their parents .

Marketable yield :

Data in **Table 6** Showed that, genotypes (parents and crosses) were significantly differed. Genotypes × seasons mean square was significant which implies to the influence of environmental factors (**Table 4**) on the performance of the evaluated genotypes. Partitioning genotypes into parents, crosses and parent vs. crosses revealed that, parents were significantly differed which indicated significant differences. Furthermore, crosses were also differed significantly. Whereas, parents vs. crosses effect was not significant.

Parents P_7, P_3 and P_6 (**Table 7**) produced the highest marketable yield (17.39, 16.64 and 15.56 t/fed respectively) on the other hand, parents, P_5, P_2 and P_8 showed lower marketable yield (14.12, 14.74 and 15.60 t/fed, respectively). These results are in agreement with those obtained by Many investigators who evaluated different onion cultivars and genotypes and detected significant variation, among them, **El-Shafie (1979), Warid and El- Shafie(1976), and Abo-Dahab *et al* ., (2018)** for marketable yield.

With respect to crosses (**Table 7**) (composites and bi-parentals), they differed significantly, over all mean of composites was significantly higher (17.16 t/fed) in compared to overall mean of parents (15.89 t/fed). However, the highest values of marketable yield were recorded by C_4 (18.68 t/fed), C_1 (17.86 t/fed) C_7 (17.77 t/fed) and C_3 (17.43 t/fed). Meanwhile, the lowest values were observed in C_8 (15.32 t/fed), C_2 (16.48 t/fed) and C_5 (16.66 t/fed).

Regarding bi-parental crosses (**Table 7**), cross B_7 gave significantly higher marketable yield (17.22 t/fed) than it's reciprocal cross B_1 (14.50 t/fed). The performance of cross B_4 was insignificant higher (16.80 t/fed) than it's reciprocal cross B5 (15.76 t/fed). Similarly, cross B_8 was insignificantly higher (15.26 t/fed) than it's reciprocal cross B_6 (14.72 t/fed), cross B_2 was insignificantly higher (15.54 t/fed) than it's reciprocal cross B_3 (14.99 t/fed). These results previously supported by **Warid and El-Shafie (1976), Shalaby *et al*., (1979), El-Sayed (1995), and Abo-Dahab (2001)** who found significant increases in marketable yield of the F_1s compared to their parents.

Culls yield:

Mean squares due genotypes, genotypes × season interaction (**Table 6**) were significant. The differences among evaluated genotypes (parents and their crosses) indicated the presence of genetic variability to select best parents for constitution of composites populations or synthetic population through using bi-parental crosses. Significant of genotypes × seasons interaction indicated the influence of environment factor on the performance of evaluated genotypes. Partitioning genotypes into parents, crosses and parent vs. crosses revealed that parents, crosses and parent vs. crosses mean squares were significant.

Concerning performance of parents and their crosses results on **Table 7** revealed that parents P_8, P_5 and P_2 recorded the highest (undesirable) culls yield (3.188, 0.797, and 0.707 t/fed, respectively). Whereas, the lowest (desirable) values were exhibited by P_1 (0.370 t/fed), P_4 (0.395 t/fed) and P_3 (0.533 t/fed). These results are in harmony with those obtained by **Dwivedi *et al*., (2017) and Abo-Dahab *et al*., (2018)** who evaluated different onion genotypes and detected significant differences among them.

Regarding composites populations, the overall mean of composites was significantly lower (0.650 t/fed) than overall parents mean (0.900 t/fed), the highest values of culls yield were detected in C_8 (1.382 t/fed), whereas the rest of composites showed lower values with no significance between each other.

With respect to the bi-parental cross, their overall mean was significantly lower (0.660 t/fed) than overall parents mean (0.900 t/fed). The highest (undesirable) value of culls yield was recorded only in

B_8 (2.378 t/fed). On the other hand, it's reciprocal cross B_6 and the rest of bi-parental and their reciprocal crosses showed lower values (desirable) of culls yield without significant difference between each other. These results were previously confirmed by those obtained by **El-Sayed (1995) and Abo-Dahab (2001)** who found significant decreases (negative heterosis) in culls yield of the F_1s compared to their parents.

Total soluble solids:

Mean squares results of total soluble solids in **Table 8** due to genotypes, parents, crosses and parents vs. crosses were significant. Genotypes × season mean squares effect was not-significant which indicates the consistent performance of the evaluated genotypes over seasons.

Table 8. Mean squares from combined analysis of variance for evaluated genotypes (parents, crosses, and parents vs. crosses) tested over two seasons (2017/2018 and 2018/2019) for total soluble solids %, dry matter%and total weight loss%.

S.O.V.	d.f	Total soluble solids %	Dry matter %	Total weight loss %
Seasons (S)	1	65.75^*	6.33^*	5512.44^*
Rep/S	4	0.85	0.61	7.74
Genotypes	23	5.27^*	7.50^*	94.32^*
Parents	7	7.81^*	12.24^*	158.08^*
Crosses	15	4.15^*	5.78^*	68.59^*
Parents vs. Crosses	1	4.38^*	0.00	33.94
G × S	23	0.566	0.52	36.15
Error	92	0.40	0.73	23.30

*significant at 0.05 level of probability.

Regarding to the performance of parents and their crosses (composites and bi-parental), results presented in **Table 9** showed that parents were differed significantly. P_5, P_7 and P_8 exhibited the highest values of TSS% (13.47, 12.68 and 12.63 %, respectively). Meanwhile, P_4 and P_2 gave the lowest values of TSS% (9.90 and 10.87 % respectively). These results were confirmed by those obtained by **El- Shafie (1979), Hegazy and El- Sheekh (1999) , El-kafoury *et al*., (1999), El-Aweel *et al*., (2000), Hanna *et al*., (2000) and Abo-Dahab *et al*., (2018)** who evaluated different onion cultivars and genotypes and detected significant variation among them for bulb TSS %.

With respect to composites populations, significant differences among evaluated composites were observed, their overall mean was significantly higher (12.27 %) than that of overall mean of parents (11.86 %). The highest values of TSS% were detected in C_8 (13.33 %), C_7 (12.90 %) and C_6 (13.08 %). Meanwhile, the lowest value was observed in C_4 (10.58%).

Regarding bi-parental crosses, their overall mean was significantly higher (12.20 %) with compared to overall parents mean (11.86 %). B_7 gave significant higher TSS% (13.57 %) than that it's reciprocal cross B_1 it showed lower value (12.32 %). B_8 produced non-significant value of TSS% (12.65 %) than it's reciprocal cross B_6 (12.18%). Moreover, B_5 exhibited higher significant value of TSS% (12.17 %) in compared to it's reciprocal cross B4 it showed lower value (10.60 %) whereas, B_3 and it's reciprocal cross B_2 gave relatively similarly percentage (12.08 and 12.00 %) respectively. Similar increases for onion TSS% was obtained with crossing onion genotypes by **Andrasfalvy and Rozse (1983b), Hanna (1987) and Abo-Dahab (2001)** who found significant increases in the F_1s compared to mid or better parents for total soluble solids TSS%.

Dry matter percentage:-

Mean squares due to genotypes and their partitions into parents, crosses (**Table 8**) for dry matter % trait were significant, whereas parents vs. crosses was not significant. Genotypes interaction with season was not significant which refer to their constant behavior during seasons, although the environmental fluctuation between seasons (Table 4).

Regarding the performance of the parents and their crosses , data of dry matter content% are presented in **Table 9**, Parents were significantly differed, P_5, P_7 and P_8 showed higher values of dry matter % (18.07, 16.88 and 16.87 %, respectively).

On the other hand the lowest values of dry matter % were recorded for P_4 (13.83 %), P_6 (14.25 %) and P_2 (15.18%). Similar results were obtained by **Hegazy and El- Sheekh (1999), El-Kafoury *et al*. (1999), Hanna *et al*. (2000) and Abo-Dahab *et al*. (2018)** who evaluated onion genotypes and detected significant differences among them for bulb dry matter %.

With respect to the performance of composites populations, they were differed significantly, their overall mean was significantly higher (16.03 %) in compared to overall parents mean (15.94 %). C_8, C_7 and C_5 gave the highest values of dry matter % (17.95, 16.82 and 16.40 %, respectively), whereas C_4 and C_3 exhibited the lowest values (14.55 and 15.35 %, respectively).

Table 9. Performance of parents and their crosses evaluated in combined analysis for total soluble solids, dry matter content, total weight loss.

Character / Genotype	Total soluble solids%	Dry matter content %	Total weight loss %
Parents			
Puss,P.r. r (P_1)	11.37 ij	16.17 b-f	23.86 bc
Texas E. grano (P_2)	10.87 jk	15.18 f-i	24.31 bc
Ori yellow (P_3)	12.27 d-h	16.25 b-f	24.35 bc
Beth Alpha (P_4)	09.90 l	13.83 j	38.24 a
E.E.y.B(P_5)	13.47 ab	18.07 a	22.83 c
Oklahoma (P_6)	11.72 hi	14.25 ij	25.34 bc
Giza.6.m. (P_7)	12.68 b-f	16.88 bc	28.81 bc
Giza20 (P_8)	12.63 c-g	16.87 bc	30.32 b
Parents mean	***11.86***	***15.94***	***27.26***
Crosses			
$P_1 \times (P_1\text{-}P_8)$ (C_1)	11.95 f-i	15.53 d-h	28.13 bc
$P_2 \times (P_1\text{-}P_8)$ (C_2)	11.87 f-i	15.75 c-g	25.14 bc
$P_3 \times (P_1\text{-}P_8)$ (C_3)	11.80 ghi	15.35 e-i	27.28 bc
$P_4 \times (P_1\text{-}P_8)$ (C_4)	10.58 kl	14.55 hij	27.77 bc
$P_5 \times (P_1\text{-}P_8)$($C_5$)	12.63 c-g	16.40 b-e	22.76 c
$P_6 \times (P_1\text{-}P_8)$ (C_6)	13.08 a-d	15.92 c-f	27.34 bc
$P_7 \times (P_1\text{-}P_8)$ (C_7)	12.90 a-e	16.82 bc	25.19 bc
$P_8 \times (P_1\text{-}P_8)$ (C_8)	13.33 abc	17.95 a	24.78 bc
Composites mean	***12.27 ****	***16.03 ****	***26.05 ****
$P_1\times (P_1+P_7)$ (B_1)	12.32 d-h	16.88 bc	26.48 bc
$P_7\times (P_7+P_1)$ (B_7)	13.57 a	17.22 ab	23.54 bc
$P_2\times (P_2+P_3)$ (B_2)	12.08 e-i	15.38 e-h	28.02 bc
$P_3\times (P_3+P_2)$ (B_3)	12.00 f-i	14.68 g-j	22.71 c
$P_4\times (P_4+P_5)$ (B_4)	10.60 kl	14.62 g-j	36.83 a
$P_5\times (P_5+P_4)$ (B_5)	12.17 e-i	16.08 b-f	23.41 c
$P_6\times (P_6+P_8)$ (B_6)	12.18 e-i	15.40 e-h	25.84 bc
$P_8\times (P_8+P_6)$ (B_8)	12.65 b-g	16.63 bcd	24.42 bc
Bi-parentals mean	***12.20 ****	***15.86***	***26.41 ****

^{Z}Values followed by a letter in common are not significantly different from each other at P=0.05 according to Duncan›s multiple range test.
*= non significant and significant at P:0.05,respectively.

Concerning to bi-parental crosses performance, it were differed significantly, their overall mean was significantly lower (15.86 %) than that of overall parents mean (15.94 %) B_7 gave non-significant higher value (17.22 %) than that of it's reciprocal cross B_1 (16.88 %). While, B_8 gave significant higher value (16.63 %) than that of it's reciprocal cross B_6 (15.40 %), B_3 gave non-significant lower value (14.68 %) than it's reciprocal cross B_2 (15.38 %). Moreover, B_4 gave significant lower value of dry matter content (14.62 %) than it's reciprocal cross B_5 (16.08%). These results were supported by the findings of **Andrasfalvy and Rozse (1983a), Hanna (1987) and Abo-Dahab (2001**) who found significant increases in the F_1s compared to mid or better parents for bulb dry matter%.

Total weight loss%:

Data in **Table 8** showed that, genotypes (parents and crosses) are differed significantly, whereas parents vs crosses and genotypes × seasons interaction effects were not significant.

Results of performance of parents and their crosses for total weight loss% are presented in **Table 9**. The parents were significantly differed, P_5, P_1, P_2 and P_3 had the lowest values of total weight loss% (TWL%)(22.83, 23.86, 24.31 and 24.35respectively). Whereas, P_4 followed by P_8 recorded the highest TWL% values (38.24 and 30.32% respectively). **Hegazy and El- Sheekh (1999), El-Aweel *et al*., (2000), Hanna *et al*., (2000), Mohanty and Prusti (2001), and Abo-Dahab *et al*. (2018)** studied the performance of some onion genotypes and found significant differences among them for storability.

With respect to composite populations their overall mean (26.05%) was significantly lower than over all parents mean (27.26%). In spite of composites are differed non-significantly, C_5, C_8, C_2 and C_7 had the lowest values of TWL% (22.76, 24.78, 25.14 and 25.19 %, respectively). Meanwhile C_1, C_4, C_6 and C_3 gave the highest values of TWL% (28.13, 27.77, 27.34 and 27.28%, respectively).

Regarding the bi-parental crosses, it had differed significantly, their overall mean (26.41%) was significantly lower than overall parents mean (27.26%). B_3 recorded the lowest value of TWL% (22.71) than that of it's reciprocal cross B_2 which had highest values 28.02% without significant differed between each other. Meanwhile, B_5 showed significant lower values (23.41%) of TWL% than it's reciprocal cross B_4 which had higher value (36.83%). The rest of bi-parental crosses were similar where B_7 and it's reciprocal cross B_1 recorded 23.54% and 26.48% TWL% similarly B_8 and B_6 gave 24.42 and 25.84, respectively. Similar findings were found by **Hosfield *et al*. (1977 b) and Abo-Dahab (2001)** who found significant heterosis over mid or better parent for onion keeping quality.

From previous results it can be concluded that, significant overall mean of composites or bi-parental populations than that overall parents mean and superiority of parents P_6 and P_2 for earliness, P_7 and P8 for high total yield, and P_7, P_3 and P_6 for high marketable yield. P_1 and P_4 for low culls yield and P_5, P_1 and P_2 for low total weight loss% could be used to form and selection new improved onion populations. Moreover the superiority of composites crosses as C_6 and C_3 for earliness, C_4, C_7 and C_1 for high total and marketable yield, C_3, C_6 and C_5 for low culls yield, C_8, C_7, C_6 and C_5 for high TSS% and DM%, C_5, C_8 and C_2 for low TWL% and superiority of Bi-Parental populations as B_3 and B_2 for earliness, B_8, B_7 and B_4 for high total yield and B_7 and B_4 for high marketable yield, B_7, B_5 and B_2 for low culls yield, B_7 and B_8 for high TSS% and DM%, B_3, B_5 and B_7 for low TWL%. Therefore, it could be used as a basic populations for new improved composites or bi-parental populations.

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تطوير وأداء بعض عشائر البصل من الهجن المركبة وثنائية الأبوين.

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اجريت هذه الدراسة فى محطة البحوث الزراعية بالجيزة – بقسم بحوث البصل – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية خلال الثلاثة مواسم الزراعية 2017/2016 ، 2018/2017، 2019/2018 بهدف تقييم اداء بعض التراكيب الوراثية و(العشائر التركيبية والصنفية الناتجة منها) لتحسين الإنتاجية وجودة البصل والقدرة التخزينية.

تم اختيار 8 تراكيب وراثية متباعدة وزراعتها فى منعزلات بطريقتين:

الأولى زرعت الثمانية أباء معاً تحت منعزل واحد

الثانية زراعة كل أبوين معاً تحت منعزل اخر

وتم تقييم الأباء والهجن الناتجة منها باستخدام تصميم القطاعات الكاملة العشوائية فى ثلاث مكررات .

أظهرت النتائج تفوق الأباء P_6, P_2, P_3 والهجن المركبة C_6, C_3 والتهجن الصنفى بين صنفين B_3, B_2, B_6 تفوقا فى صفة التبكير فى النضج.

كما اتضح من النتائج تفوق الأباء P_8, P_7 والهجن المركبة C_4, C_7, C_1 والتهجن الصنفى بين صنفين B_8, B_7, B_4 تفوقا فى المحصول الكلى.

بينما أظهرت الأباء P_7, P_3, P_6 والهجن المركبة C_4, C_1, C_7 والتهجين الصنفى بين صنفينB_7, B_4 تفوقا فى المحصول الصالح للتسويق. بينما فى صفة محصول النقضة فقد اوضحت النتائج تفوق الأباء P_3, P_4, P_1 والهجن المركبة C_3, C_6, C_5 وكذلك التهجين الصنفى بين صنفين B_7, B_5, B_2 تفوقا فى صفة النقضة . كما اظهرت الأباء P_5, P_7, P_8 والهجن المركبة C8, C_6, C_7 والتهجين الصنفى بين صنفين B_7, B_8, B_1 أعلى القيم فى نسبة المواد الصلبة الذائبة الكلية وكذلك نسبة المادة الجافة.

اما بالنسبة لصفة الفقد الكلى فى المخزن فقد أظهرت الأباء P_5, P_1 والهجن المركبة C_5, C_8 والتهجن الصنفى بين صنفين B_5, B_7, B_3تفوقا فى القدرة التخزينية وانخفاض الفقد الكلى بعد التخزين.