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SCREENING AND ESTIMATION OF GENETIC PARAMETERS IN SOME ONION GENOTYPES FOR ONION PRODUCTION THROUGH SETS

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ABSTRACT

An experiment for screening of 17 onion genotypes grown through sets was conducted during the two successive seasons, 2014/015 and 2015/016, at Giza Research Station, Field Crops Research Institute, Agricultural Research Center to study their response to produce onion bulbs through sets and estimate some genetic parameters for economical bulb traits. Randomized Complete Block Design (RCBD) with three replications was used. Significant differences among the genotypes were detected for all studied traits. Genotype "Composite 12" recorded high values of plant height, number of leaves/plant, total yield, marketable yield , culls yield and low value of total weight loss 90 days after harvesting, " Composite 8" showed high values of plant height, marketable yield and produced lower values of double and bolter bulbs percentage. "Composite 18" exhibited superiority for producing marketable yield with lower value of bolter bulbs percentage. GCV% and PCV% values were medium to high for total yield, marketable yield, culls yield, bolters%, doubles %, small bulbs %, total bulbs weight loss and low for plant height and number of leaves/plant. Narrow difference between (PCV%) and (GCV%) was observed for plant height, total yield, culls yield, whereas wide difference for marketable yield, doubles% and small bulbs% was detected. High to moderate heritability (h^2b) coupled with high to moderate genetic advance as percentage of means (GAM) were observed for total yield, marketable yield, culls yield, bolters bulbs%, doubles bulb%, small bulbs% and total bulbs weight loss, indicating that these traits are controlled by additive gene action and less affected by environment so, it could be improved through mass selection, whereas plant height and number leaves/plant displayed high to medium h^2b associated with low GAM%, indicating that these traits are controlled by non additive gene action and highly affected by environmental factors, therefore the simple selection could be inefficient to improve these traits. It could be concluded that, genotypes " Composite 12", " Composite 8" and "Composite 18" could be used for producing onion bulbs through sets and selection could be efficient to improve total yield, marketable yield, culls yield, bolters bulbs%, doubles bulb%, small bulbs% and total bulbs weight loss%.

Key word: ***Allium cep L, Genotypic variability, Heritability, Genetic advance***.

INTRODUCTION

Onion (*Alium cepa* L.) is considered as one of the most important crops; total world planted area reached 4,811,461 ha, produced 89,216,892 tons (FAO, 2015). Egypt considered one of the most important producers of dry onion in the world, it ranked the fourth in top ten onion producer countries in the world, preceded by China, India and United State of America, furthermore it also ranked the fourth in the top ten exporter countries (591,553 tons) and preceded by China main land (869,753tons), India (1,047,474 tons) and Nether land (1,193,747 tons) during 2015 season (FAO, 2015).

In Egypt the main method for grown onion is by transplanting of seedlings during November-December and harvested mature bulbs during March-May. Total planted area devoted yearly for onion production reached to 196,968 feddans (1 feddan = 4200 m^2) and produced 2,888,791 tons, with an average yield of 14.666 tons/feddan (Anonymous 2015).The onion bulbs production in winter season either used for fresh consumption and exportation or dehydration and gradually availability of fresh onion bulbs decreases, hence its price increases during October - May which also affects exportation and the dehydration industry requirements during that period. The early 1980, Onion Research Department introduced and improved the local method, which called "Mokawar onion", farmer used to planting the small bulbs which produced in previous season during August - July and harvested mature bulbs during December-January.This production have a high percentage of doubles, bolters bulbs reached to 90-95%. Onion Research Department improved that method and recommended planting onion from sets (8-16 mm) from Giza 6 Mohassan cultivar, most of this production was used only for local consumption. The area grown by onion sets was about 6816 feddans which represents 3.4% of the total area of onion in Egypt and produced 93657 tons which represents 3.2%, with an average yield of 13.774 tons/feddan (Anonymous 2015). However, onion from sets production has many advantages as early maturity (December-January), escaping from white rot diseases during winter season.

Most of onion bulbs production from sets characterized by high percentage of doubles, bolters, thick neck, tend to sprouting rabidly and have low short-storage life, consequently it does not meet the needs of imported countries markets.

Therefore, there is a need for improving onion bulbs quality grown from sets and develop suited onion cultivars for onion bulbs production form sets. Many investigators studied the performance and genetic parameters of onion genotypes for onion production through seedling and few for onion from sets allover the world and Egypt. Jones and Man (1963) clarified that choice of cultivar is very important in growing onion from sets, it must be rapid, early maturing and attractive. Significant differences variation among onion genotypes for plant height, number of leaves/plant, total yield marketable yield, culls yield, double bulbs%, bolter bulbs% , small bulbs% and total weight loss after storage period have been reported (El –Shafie 1980; Koriem and Farag 1990; Farag and Koriem 1990; Shalaby *et al* 1991a, b, c; Madisa 1994; Islam *et al* 1999; Seetohul and Hanoomanjee

1999; Parys 1999; Khokhar *et al* 2001; Mohanty and Prusti 2001; Cheema *et al* 2002; Khokhar *et al* 2002; Naz and Amjad 2004 and Degewione *et al* 2011)

Genetic parameters of onion characters estimates have been reported by several investigators, high values of PCV and GCV were observed by Haydar *et al* (2007) for plant height, Hosmani *et al* (2010), Morsy (2010), Dewangan and Sahu (2014), Dwivedi *et al* (2017) for total yield, Degewione *et al* (2011) and Dewangan and Sahu (2014) for marketable yield, Degewione *et al* (2014) for culls yield, Khosa and Dhatt (2013) for bolter bulbs%, Degewione *et al* (2011) for total bulb weight loss. Meanwhile medium values were found by Khosa and Dhatt (2013) and Degewione *et al* (2011) for plant height, Morsy (2010), Sharma *et al* (2017) and Singh *et al* (2017) for number of leaves/plant, Santra *et al* (2017), Sharma *et al* (2017), Degewione *et al*, (2011) and Aditika *et al* (2017) for total yield, Santra *et al* (2017 and Sharma *et al* (2017) for marketable yield, whereas low values were recorded by Morsy (2010), Degewione *et al* (2011), Aditika *et al* (2017), Dwivedi *et al* (2017), Santra *et al* (2017), Sharma *et al* (2017) and Singh *et al* (2017) for plant height, Aditika *et al* (2017), Dwivedi *et al* (2017) and Santra *et al* (2017) for number of leaves/plant, Mohanty (2001and 2004) and Singh *et al* (2017) for total yield, Haydar *et al* (2007) for split bulbs percentage.

Concerning brood sense heritability estimates, high values were noticed by Haydar *et al* (2007), Morsy (2010), Khosa and Dhatt (2013), Aditika *et al* (2017), Dwivedi *et al* (2017), Santra *et al* (2017), Sharma *et al* (2017), Singh *et al* (2017) for plant height. Morsy (2010), Aditika *et al* (2017), Dwivedi *et al* (2017), Santra *et al* (2017), Sharma *et al* (2017) and Singh *et al* (2017) reported high h^2_b for number of leaves/plant. Haydar *et al* 2007, Hosmani *et al* (2010), Morsy (2010), Dewangan and Sahu (2014), Santra *et al* (2017), Sharma *et al* (2017), Degewione *et al* (2011), Aditika *et al* (2017), Dwivedi *et al* (2017) and Singh *et al* (2017) recorded high values of h^2_b for total yield. Degewione *et al* (2011), Dewangan and Sahu (2014), Santra *et al* (2017), Sharma *et al* (2017) reported high values of h^2_b for marketable yield. Khosa and Dhatt (2013) reported high h^2_b for bolting bulbs %. Degewione *et al* (2011) recorded high h^2_b for total weight loss. Moderate values of h^2_b were found by Mohanty (2001 and 2004), Hosmani *et al* (2010), Degewione *et al* (2011), Dewangan and Sahu (2014) for plant height, Mohanty (2001 and 2004), Degewione *et al* (2011), Dewangan and Sahu (2014) for number of leaves/plant, Mohanty (2001and 2004) for total yield, Degewione *et al* (2011) for marketable yield. Low values of h^2_b were reported by Haydar *et al* (2007) for number of split bulbs.

In regard with genetic advance as percentage of mean, high values were reported by Mohanty (2001and 2004), Morsy (2010), Sharma *et al* (2017) for number of leaves/plant, Hosmani *et al* (2010), Morsy (2010), Dewangan and Sahu (2014), Santra *et al* (2017), Sharma *et al* (2017), Degewione *et al* (2011), Aditika *et al* (2017), Dwivedi *et al* (2017) for total yield. Degewione *et al* (2011), Dewangan and Sahu (2014), Santra *et al* (2017) and Sharma *et al* (2017) for marketable yield, Degewione *et al* (2011) for marketable yield, Haydar *et al* (2007) for number of split bulbs, Degwione *et al* (2011) for total bulb weight loss. Medium values of GAM were reported by Mohanty (2001), Haydar *et al* (2007), Morsy (2010), Dewangan and Sahu (2014), Aditika *et al* (2017), Dwivedi *et al* (2017), Sharma *et al* (2017) and Singh *et al* (2017) for plant height, Dewangan and Sahu (2014), Aditika *et al* (2017), Dwivedi *et al* (2017), Singh *et al* (2017), Degewione *et al* (2011) for number of leaves/plant, Singh *et al* (2017) for total yield while low values were estimated by Mohanty (2004), Hosmani *et al* (2010), Degewione *et al* (2011) and Santra *et al* (2017) for plant height, Mohanty (2001and 2004) for total yield.

To improve onion bulbs quality produced by sets, new onion cultivars adapted to produce onion form sets are needed, so information about the performance of cultivars and detecting variance, genetic parameters for some onion traits are prerequisite for efficient selection program, and improvement of onion bulbs yield and quality from sets. Therefore, the objectives of this investigation were evaluation of the response of some onion genotypes to produce onion from sets, estimation of variance and genetic parameters of onion bulbs yield, quality and storability traits.

MATERIALS AND METHODS

This investigation was carried out at Giza Research Station, Field Crops Research Institute, Agricultural Research Center, Giza Governorate, Egypt, during 2014/015 and 2015/016 seasons to study the performance of seventeen onion genotypes and to estimate the genetic variability, heritability and expected genetic advance from selection. The name of evaluated genotypes in the present study, their method of development, bulb color and country of origin are presented in Table 1. For production of onion from sets two steps must be taken. First, seeds are sown to get onion sets. Second, sets are replanted for the production of bulb crop. Seeds of 17 onion genotypes developed by Onion Research Department, Field Crops Research Institute, Agricultural Research Center, Giza were sown in the nursery on the 15th of January of each growing season to produce onion sets with a rate of 30 kg/fed.

Table 1. Onion genotypes evaluated in 2014/015 and 2015/016, their method of development, bulb color and country of origin in the present study.

Genotype	Development method	Bulb color	Origin
Z 218 white	An advanced selection from an introduced cv. from USA	White	USA
T.E.Y.G. X Giza20	An advanced selection from single cross between cv. T.E.Y.G. with Giza 20 cv.	Yellow	Egypt
Giza20 x Ori	An advanced selection from single cross between Giza 20 cv. with cv. Ori	Yellow	Egypt
Composite El-Bustan	An advanced selection from single cross between two Egyptian cultivars.	Yellow	Egypt
Giza20 Nucleus	An advanced selection from cv. Giza 20 strains	Yellow	Egypt
Behairy 1866	An advanced selection from Behairy strains	Yellow	Egypt
Giza 6 Mohassan	An advanced selection from cv. Giza 6 Mohassan strains	Yellow	Egypt
Giza 6 Mohassan Oblong	An advanced selection from cv. Giza 6 Mohassan strains	Yellow	Egypt
Composite 8	An advanced selection from single cross between two Egyptian and 10 American cultivars.	Yellow	Egypt
Composite 12	An advanced selection from single cross between two Egyptian and 10 American cultivars.	Yellow	Egypt
Composite 18	An advanced selection from single cross between two Egyptian and 10 American cultivars.	Yellow	Egypt
Composite 16	An advanced selection from single cross between two Egyptian and 10 American cultivars.	White	Egypt
Puss.P.R.R.	An advanced selection from introduced cv. Puss.P.RR.	Yellow	USA
Shandweel 1	Selection from bulb samples collected from Sohag province	Yellow	Egypt
Giza 6 Mohassan	Selection from cv. Giza 6 which selected from Upper Egypt strain (Saiedi).	Yellow	Egypt
Giza Red	Selection from Behairy red strains.	Red	Egypt
Giza 20	Selection from Egyptian Deltan types (Behairy) which collected from different provinces of delta regions.	Yellow	Egypt

Sets were harvested on May 25th in both seasons, then cured for 3 weeks in normal conditions; their dry foliage and roots were removed and sized into 8-16 mm diameter, then stored in natural ventilation conditions till replanting in the permanent field to produce bulbs.

Sets (8-16 mm) of 17 onion genotypes were replanted 7 cm apart on both sides of ridges 3 m long and 0.65 m wide on September 10th and September 15th in the two seasons, respectively. The soil of the experimental field was clay loam. The plot size was 2 x3 m (1/700 feddan). Each plot consisted of 3 ridges (6 rows). All cultural practices concerning sets production or onion production from sets were applied. The experimental design used in this experiment was randomized complete blocks design with three replicates

Data recorded

Data were recorded for the following characters

Vegetative growth characters

After 90 days from replanting the sets, 10 randomly selected plants were taken from each plot to measure plant height (cm), number of leaves/plant

Yield and its components

At harvest time, all plants in the experimental plot were harvested when 50 % of tops down cured for 3 weeks, then tops and roots were topped and the following data were estimated as follows:

a- Total yield (t/fed): It was calculated on the basis of yield for the experimental plot in tons/fed.

b- Marketable yield (t/fed): It was determined as the weight of single bulb yield for each experimental plot.

c- Culls yield (t/fed): It includes small bulbs (less than 3.5 cm diameter), doubles, bolters, off-color and scallion bulbs.

d- Bolter bulbs percentage.

e- Double bulbs percentage.

f- Small bulb percentage, i.e. bulbs less than 3.5 cm in diameter

Storability

A random sample from each plot and genotype containing 50 sound bulbs of marketable yield were weighted and stored in common jut bags under room conditions (20±5c º and 65± 5% relative humidity). Storability expressed as the total weight loss% 3 months after harvest, total weight loss% was calculated according to Wills *et al* (1982) as follow: Total weight loss percentage =[(Initial weight- Weight after storage)/Initial weight] ×100.

Statistical analysis

Separate analysis of variance for each season and combined analysis of variance across the two seasons were performed (Steel *et al* 1997), Bartelet test was done prior the combined analysis (Gomiz and Gomiz 1984). Table (2) shows form of analysis of variance and expected mean squares in a separate season.

Table 2. Analysis of variance and expected mean squares for the data of each season.

SOV	df	Mean squares	Expectation of mean squares
Replications	**r-1**		
Genotypes	**g-1**	**M_2**	**$\delta^2 e + r\delta^2 g$**
Error	**(r-1) (g-1)**	**M_1**	**$\delta^2 e$**
Total	**rg-1**		

$\delta^2_g = (M_2 - M_1)/r$, $\delta^2_{ph} = (\delta^2 g + \delta^2 e/r$

Where: $\delta^2 g$ = Genotypic variance, $\delta^2 e$ = Error variance, **r** = Number of replications and **g** = Number of genotypes, respectively.0

The means of genotypes were compared using Duncan' s multiple range test (Walter and Duncan 1969) at 0.05 probability level. Genetic parameters were calculated based on each season from the values of the expected mean squares as shown in Table 2. Phenotypic (PCV) and genotypic (GCV) coefficients of variation and broad sense heritability (h^2_b) were calculated according to Falconer (1981).

Phenotypic coefficient of variation (PCV) was calculated as:

$$\textbf{PCV} = \frac{\sqrt{\delta^2_{Ph}}}{\bar{X}} \times 100$$

Where: $\bar{X}$ = Grand mean of the seventeen genotypes.

Genotypic coefficient of variation (GCV) was calculated as:

$$\textbf{GCV} = \frac{\sqrt{\delta^2_{g}}}{\bar{X}} \times 100$$

Where: $\bar{X}$ = Grand mean of the seventeen genotypes.

PCV and GCV were classified as reported by Siva Subramanian and Menon (1973) to three categories (0 – 10 % = Low; 11% – 20 % = Moderate and > 20% = High).

Broad sense heritability (h^2_b) was calculated as:

$$\mathbf{h^2_b} = \frac{\delta^2_{g}}{\delta^2_{Ph}} \times 100$$

Heritability values were categorized as recorded by Robinson *et al* (1951) as 0 – 30% = Low; 31% – 60% = Moderate and > 60% = High.

Genetic advance (GA) and genetic advance as percentage of mean (GAM%) from selection was calculated according to Robinson *et al* (1949) when selection intensity was 5%, consequently standardized selection differential (k) was 2.063.

GA = $K \times \delta_{Ph} \times h^2_b$

Where:

K = Standardized selection differential.

$\boldsymbol{\delta_{Ph}}$ = Standard deviation for phenotypic variance.

Expected genetic advance as percentage of mean (GAM %) was calculated as **GAM%** = (GA/grand mean) × 100.

GAM% was classified as suggested by Falconer and Mackay (1996) to three categories as follows: 0 – 10% = Low; 11 – 20% = Moderate and > 20% = High.

RESULTS AND DISCUSSION

Performance of onion genotypes

Plant height

Data on Performance of 17 genotypes for plant height are presented in Table 3. Genotypes were significantly differed in both seasons as well as across seasons. Genotypes "Giza 20", "Giza Red", "Puss p.r.r.", "Composite 8", "Composite 12" and "Shandaweel 1" had the tallest plant (89.87, 86.73, 84.10, 83.68, 82.60 cm, respectively), on the other hand, two genotypes "Composite 18" and "Z 218 white" recorded the shortest plant height (62.70, 62.70 cm, respectively) in the first season. Genotypes "Composite 12" and "Composite 8" recorded the highest value of plant height (84.77, 83.00 cm, respectively), on the other hand the lowest values were recorded with genotypes "Composite 16"(70.89 cm) in the second season.

Data of combined analysis revealed that genotypes "Giza 20", "Composite 12", "Composite 8", "Giza Red" and "Giza 6 Mohassan", recorded the highest value of plant height (84.54, 83.69, 83.34, 81.78, 80.05 cm, respectively. Meanwhile, genotype "Z 218 white", exhibited the lowest value (67.89 cm), these results indicated the presence of variation among the tested genotypes. Similarly, Islam *et al* (1999), Hosamani *et al* (2010) Dewangan and Sahu (2014) Santra *et al* (2017) and Singh *et al* (2017) detected significant differences among their evaluated onion genotypes.

Number of leaves/plant

Data on performance of 17 onion genotypes for number of leaves/plant are presented in Table 3. Significant differences were detected among onion genotypes during both seasons, as well as combined across seasons. In the first season, genotypes "Giza 20","Shandaweel 1" and "Giza 20 Nucleus" showed the highest number of leaves/plant. (15.20, 14.67, 13.10, respectively, while genotypes "Giza 20 x Ori" and "T.E.Y.G x Giza 20" exhibited the lowest values (9.90 and 10.60, respectively). In the second season, genotypes "Giza 6 D.M.R", "Giza 6 oblong", "Giza 20 x Ori" and "Composite 12" showed the highest number of leaves plant (13.49, 13.35, 12.99 and 12.99, respectively), but, genotypes "Composite 16" exhibited the lowest value (8.66).

Table 3. Means of individual season and combined across season for plant height and number of leaves/plant of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Genotype	Plant height (cm)			Number of leaves/plant		
	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.
Z 218 white	62.70 h	73.08 bc	67.89 f	10.80 cde	9.46 bc	10.13 bc
T.E.Y.G x Giza 20	70.00 gh	80.33 abc	75.17 bcde	10.60 de	12.16 ab	11.38 abc
Giza 20 x Ori	74.33 defg	72.83 bc	73.58 cdef	9.90 e	12.99 a	11.45 abc
Composite El-Bustan	70.60 fgh	74.78 abc	72.69 def	11.00 cde	11.16 abc	11.08 abc
Giza 20 Nucleus	75.20 cdefg	76.11 abc	75.65 bcde	13.10 abc	11.16 abc	12.13 ab
Behairy 1866	72.90 efg	77.33 abc	75.12 bcde	12.50 bcd	10.48 abc	11.49 abc
Giza 6 D.M.R	79.20 bcdefg	80.00 abc	79.60 abcd	11.00 cde	13.49 a	12.25 a
Giza 6 Mohassan oblong	74.40 defg	81.44 abc	77.92 abcde	12.65 bcd	13.35 a	13.00 a
Composite 8	83.68 abcd	83.00 ab	83.34 a	12.46 bcd	11.33 abc	11.90 ab
Composite 12	82.60 abcd	84.77 a	83.69 a	12.80 bcd	12.99 a	12.90 a
Composite 18	62.70 h	81.66 abc	72.18 ef	12.00 cde	11.66 abc	11.83 ab
Composite 16	78.07 bcdefg	70.89 c	74.48 cdef	10.93 cde	8.66 c	9.79 c
Puss p.r.r.	84.10 abc	74.66 abc	79.38 abcd	11.20 cde	11.33 abc	11.27 abc
Shandaweel 1	82.33 abcde	73.83 bc	78.08 abcde	14.67 ab	10.99 abc	12.83 a
Giza 6 Mohassan	79.93 bcdef	80.16 abc	80.05 abc	10.73 cde	11.83 abc	11.28 abc
Giza Red	86.73 ab	76.83 abc	81.78 ab	12.67 bcd	10.83 abc	11.75 abc
Giza 20	89.87 a	79.22 abc	84.54 a	15.20 a	11.07 abc	13.14 a
F test at 0.05	*	*	*	*	*	*

A value followed by a letter common are not significant different from each other at P=0.05 according to Duncan, s multiple range test, *=Significant at p=0.05

Combined analysis across seasons showed that genotypes "Giza 20" "Giza 6 oblong", "Composite 12", "Shandaweel 1" and "Giza 6 D.M.R" recorded the highest number of leaves /plant (13.14, 13.00, 12.90, 12.83, 12.25, respectively). Meanwhile, genotype "Composite 16" was the lowest one (9.79). These results refer to the genetic variability among evaluated materials which provide a good oportunity for onion improvement, these results were confirmed by the findings of Koriem and Farrag (1990), Islam *et al* (1999), Cheema *et al* (2002), Hosamani *et al* (2010), Abu-Azoom *et al* (2014) Dwivedi *et al* (2017) and Singh *et al* (2017) who indicated significant differences among their tested genotypes.

Total yield

Results presented in Table 4 showed significant differences among the 17 onion genotypes during both seasons as well as across seasons. In the first season, genotype "Composite 12" had the highest total yield (24.02 t/fed). Meanwhile, the lowest total yield was shown by genotypes "Z 218 white"(11.32t/fed) and "Giza 20"(12.12t/fed); the rest of genotypes were in between. In the second season, the highest total yield was obtained by genotypes "T.E.Y.G x Giza 20" (18.62 t/fed), "Shandaweel 1 "(17.31 t/fed) and "Composite 12"(16.80 t/fed).Whereas, genotype "Giza 20" was the lowest total yield (10.22 t/fed).

Data of combined analysis across both seasons revealed significant differences among genotypes. The highest total yield was obtained by genotypes "Composite 12" (20.41 t/fed), "T.E.Y.G x Giza 20"(18.64 t/fed) and "Shandaweel 1" (18.31 t/fed), meanwhile the lowest total yield was obtained by Giza 20 cv. (11.17 t/fed). Significant differences among the genotypes reflect their different responses and the wide variation and pointed that, selection among these genotypes for improvement of onion total yield could be achieved. Similar differences among genotypes were reported by Koriem and Farrag (1990), Shalaby *et al* (1991a, b and c), Madisa (1994) Koriem *et al* (1996), Islam *et al* (1999), Seetohul and Hanoomanjee (1999), Mohanty and Prusti (2001), Cheema *et al* (2002), Hosamani *et al* (2010), Abu-Azoom *et al* (2014), Dewangan and Sahu (2014), Roy *et al* (2016) and Dwivedi *et al* (2017) and Santra *et al* (2017)

Culls yield

Data in Table (4) showed that there is significant difference among all tested genotypes not only in the two seasons but also in combined across seasons. The highest culls yield resulted with genotypes "Composite 12"(17.21 t/fed), "Shandaweel 1"(16.90t/fed), "Behairy 1866"(12.23 t/fed), "Giza Red"(15.73 t/fed) and "T.E.Y.G x Giza 20"(15.32 t/fed). While, the lowest culls yield was obtained by genotype "Z 218 white"(8.75 t/fed).

Furthermore in the second season, genotypes "T.E.Y.G x Giza 20" and "Shandaweel 1" exhibited the highest culls yield (16.65 and 15.68 t/fed, respectively). On the other hand, genotypes "Composite 18" and "Giza 20" cv. showed the lowest values (7.72 and 9.59 t/fed, respectively).

Table 4. Means of individual season and combined across seasons for total yield, culls yield, and marketable yield of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Genotype	Total yield (t/fed)			Culls yield (t/fed)			Marketable yield (t/fed)		
	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.
Z 218 white	11.32 f	12.96 defg	12.14 hi	8.75 g	11.69 cde	10.22 h	2.56 fgh	1.26 de	1.91 cd
T.E.Y.G x Giza 20	18.66 bcd	18.62 a	18.64 ab	15.32 abcde	16.65 a	15.98 a	3.34 efg	1.96 cd	2.65 bc
Giza 20 x Ori	14.07 ef	14.79 bcd	14.43 efg	10.61 fg	13.56 bc	12.09 defgh	3.45 efg	1.22 de	2.34 bcd
Composite El-Bustan	15.68 de	13.33 def	14.51 efg	12.88 def	11.87 cde	12.38 defg	2.80 efgh	1.45 de	2.12 bcd
Giza 20 Nucleus	14.15 ef	11.66 efg	12.91 ghi	12.23 ef	10.24 de	11.24 efgh	1.91 gh	1.42 de	1.67 cd
Behairy 1866	19.74 b	15.51 bcd	17.62 bc	16.58 abc	13.79 bc	15.19 ab	3.16 efgh	1.71 de	2.44 bc
Giza 6 D.M.R	15.46 de	14.85 bcd	15.15 def	13.63 cdef	13.98 bc	13.80 bcd	1.82 ghi	0.87 de	1.35 de
Giza 6 Mohassan	16.67 bcde	15.07 bcd	15.87 cde	13.76 bcdef	14.05 bc	13.91 bcd	2.90 efgh	1.02 de	1.96 cd
Composite 8	19.74 b	14.69 bcd	17.21 bcd	11.62 fg	11.82 cde	11.72 efgh	8.12 a	2.87 bc	5.49 a
Composite 12	24.02 a	16.80 abc	20.41 a	17.21 a	12.40 cd	14.81 abc	6.80 ab	4.39 a	5.60 a
Composite 18	19.85 b	11.25 fg	15.55 def	13.90 bcdef	7.72 f	10.81 fgh	5.95 bc	3.51 ab	4.73 a
Composite 16	15.78 de	11.41 fg	13.59 fgh	10.65 fg	10.30 de	10.47 gh	5.12 cd	1.11 de	3.12 b
Puss p.r.r.	16.09 de	14.28 cde	15.19 def	11.65 fg	12.58 cd	12.12 defgh	4.43 cde	1.69 de	3.06 b
Shandaweel 1	19.32 be	17.31 ab	18.31 b	16.90 ab	15.68 ab	16.29 a	2.41 gh	1.63 de	2.02 cd
Giza 6 Mohassan	16.18 cde	14.62 bcd	15.40 def	11.94 fg	13.47 bc	12.71 def	4.24 def	1.14 de	2.69 bc
Giza Red	17.28 bcde	11.32 fg	14.30 efg	15.73 abcd	10.25 de	12.09 cde	1.54 hi	1.07 de	1.31 de
Giza 20	12.12 f	10.22 g	11.17 i	11.82 fg	9.59 ef	10.70 fgh	0.29 i	0.62 e	0.46 e
F test at 0.05	*	*	*	*	*	*	*	*	*

A value followed by a letter common are not significant different from each other at P=0.05 according to Duncan, s multiple range test,*=Significant at p=0.05

Combined analysis indicated that genotypes "Shandaweel 1", "T.E.Y.G x Giza 20", "Behairy 1866" and "Composite 12" showed the highest value of culls yield (16.29, 15.98, 15.19, 14.81 t/fed., respectively), whereas genotype "Z 218 white" gave the lowest value of culls yield (10.22 t/fed).Significant differences among the genotypes reflect thier different responses; such variability among genotypes allow for selecting the lower culls yield genotypes. Many investigators detected the significant differences among onion genotypes in producing culls yield (Shalaby *et al* 1991a, b and c, Koriem and Farrag 1996 and Koriem *et al* 1996 and Dwivedi *et al* 2017).

Marketable yield

Results presented in Table 4 for marketable yield showed significant differences among the genotypes in both seasons as well as combined data. In the first season genotypes "Composite 8" and "Composite 12" showed the highest single bulbs yield (8.12 and 6.80 t/fed.), whereas cultivar "Giza 20" gave the lowest value (0.290 t/fed). In the second season, the highest single bulbs yield was obtained by "Composite 12"(4.39 t/fed) and "Composite 18"(6.80 t/fed), while "Giza 20" cv. showed the lowest value (0.620 t/fed).

Combined analysis indicated that the highest single bulbs yield was recorded by genotype "Composite 12"(5.60 t/fed) followed by "Composite 8" (5.49 t/fed) and "Composite 18" (4.73 t/fed) whereas, the lowest values were exhibited by cultivar "Giza 20"(0.46 t/fed) followed by "Giza Red"(1.310 t/fed) and "Giza 6 D.M.R"(1.35 t/fed). Significant differences among the genotypes refer to the existence of variability which reflect their genetic background. These findings are in agreement with those reported by Koriem and Farrag (1990), Shalaby *et al* (1991a, b and c), Koriem and Farrag (1996), Koriem *et al* (1996), Islam *et al* (1999) and Dewangan and Sahu (2014).

Bolter bulbs percentage

Results recorded in Table 5 revealed significant differences among genotypes for bolter bulbs percentage in both seasons and combined across seasons. In the first season, genotypes "T.E.Y.G x Giza 20", "Composite El-Bustan" and "Composite 8" produced the highest values of bolter bulbs% (36.72, 28.73 and 26.16%, respectively), whereas the lowest values were exhibited by genotype "Puss p.r.r." (3.03 %)"followed by "Composite 16" (3.47%), Giza20" (4.68%),"Composite18" (5.15%), "Giza Red" (6.42%), "Giza 6 D.M.R" (6.55%) and "Giza 6 Mohassan" (6.69%).

Other genotypes ranked in between. In the second season, genotypes "Giza 6 D.M.R" and "Composite 16" gave the highest bolter bulbs percentage (89.45 and 84.78%). On the other hand, the lowest values were recorded with genotypes "Composite 18"(52.64%) followed by "Composite 12", (55.43%) and "Composite 8"(62.96%).

Table 5. Means of individual season and combined across seasons for bolter bulbs, double bulbs% and Small bulbs% of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Genotype	Bolter bulbs%			Double bulbs%			Small bulbs%		
	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.
Z 218 white	7.34 ef	72.10 bcd	39.72 def	58.01 bcd	15.95 a	36.98 abc	9.27 bcd	1.20 e	5.23 cde
T.E.Y.G x Giza 20	36.72 a	74.96 bcd	55.84 a	34.35 e	11.81 abc	23.08 f	15.49 a	3.67 cde	9.58 b
Giza 20 x Ori	8.17 ef	74.69 bcd	41.43 cdef	56.36 bcd	11.13 abcd	33.74 abcd	11.55 abc	6.05 bcde	8.80 bc
Composite El-Bustan	28.72 ab	74.12 bcd	51.42 ab	47.47 de	6.35 cde	26.91 def	5.04 def	8.49 abc	6.77 bcd
Giza 20 Nucleus	11.12 ef	78.28 abc	44.70 bcde	67.09 abc	9.96 abcde	38.52 ab	7.19 bcdef	2.77 de	4.98 cde
Behairy 1866	23.53 bcd	75.30 bcd	49.41 abc	53.98 cd	7.53 cde	30.76 bcdef	7.87 bcde	6.00 bcde	6.93 bcd
Giza 6 D.M.R	6.55 f	89.45 a	48.00 abcd	73.86 ab	4.34 e	39.10 ab	5.55 def	1.65 e	3.60 de
Giza 6 Mohassan oblong	14.54 cdef	80.59 abc	47.56 abcd	67.84 abc	9.82 abcde	38.83 ab	1.96 f	3.34 cde	2.65 e
Composite 8	26.16 abc	62.96 de	44.56 bcde	33.54 e	14.28 ab	23.91 ef	3.20 ef	7.19 bcd	5.20 cde
Composite 12	13.95 def	55.43 e	34.69 fg	47.65 de	9.98 abcde	28.81 cdef	8.10 bcde	9.22 ab	8.66 bc
Composite 18	5.15 f	52.64 e	28.90 g	54.26 cd	15.46 a	34.86 abcd	8.88 bcde	3.20 cde	6.04 bcde
Composite 16	3.74 f	84.78 ab	44.26 bcde	52.33 cd	4.85 de	28.59 cdef	12.89 ab	1.24 e	7.06 bcd
Puss p.r.r.	3.03 f	71.28 cd	37.16 ef	58.75 bcd	11.94 abc	35.35 abcd	8.78 bcde	5.48 bcde	7.13 bcd
Shandaweel 1	19.39 bcde	75.61 bc	47.50 abcd	58.25 bcd	7.99 bcde	33.12 abcde	6.11 cdef	7.31 bcd	6.71 bcd
Giza 6 Mohassan	6.69 f	77.71 abc	42.20 cdef	58.87 bcd	9.75 abcde	34.32 abcd	10.04 bcd	6.04 bcde	8.04 bc
Giza Red	6.42 f	83.74 abc	45.08 bcde	77.05 a	6.65 cde	41.85 a	8.67 bcde	1.37 e	5.02 cde
Giza 20	4.68 f	78.05 abc	41.37 cdef	76.47 a	4.47 e	40.47 a	16.38 a	12.64 a	14.51 a
F test at 0.05	*	*	*	*	*	*	*	*	*

A value followed by a letter common are not significant different from each other at P=0.05 according to Duncan, s multiple range test,*=Significant at p=0.05

Data of combined analysis revealed that, the highest percentage of bolter bulbs was recorded with genotypes "T.E.Y.G x Giza 20"(55.84%), and "Composite El-Bustan" (51.42%). Meanwhile, genotypes "Composite 18" and "Composite 12" gave the lowest values (28.90 and 34.69%, respectively). Significant differences among the genotypes it could be attributed to their genetic makeup and allows for selecting genotypes that had lower percentage of bolter bulbs. Similar results were obtained by Meer Van der (1982), Farrag and Koriem (1990), Shalaby *et al* (1991a, b and c), Koriem and Farrag (1996), Koriem *et al* (1996), Dwivedi *et al* (2017) and Santra *et al* (2017).

Double bulbs percentage

Data of doubles bulbs percentage are given in Table (5). Significant differences for this trait were found among genotypes in each season and combined across years. In the first season, the highest values of double bulbs% were obtained with genotype "Giza Red"(77.05%) followed by "Giza 20"(76.47%), "Giza 6 D.M.R"(73.86 %), "Giza 6 oblong" (67.84%) and "Giza 20 Nucleus"(67.09%), but, genotypes "Composite 8"(33.54%),"T.E.Y.G xGiza 20"(34.35%,"Composite El-Bustan"(47.47%) and "Composite 12"(47.65) showed the lowest value. In the second season, genotypes "Z 218 white", "T.E.Y.G x Giza 20", "Composite 8" gave the highest values (15.95, 11.81 and 14.28%, respectively) while, genotype "Giza 6 D.M.R" and "Giza 20" showed the lowest values (4.34 and 4.47%, respectively).

Combined analysis revealed that, the highest values of double bulbs%. were exhibited by cvs. "Giza Red" (41.85%) followed by "Giza 20" (40.47%), "Giza 6 D.M.R" (39.10%), "Giza 6 oblong" (38.83%) and "Giza 20 Nucleus" (38.52%). On the other hand, the lowest values were obtained with genotypes "T.E.Y.G x Giza 20"(23.08%),"Composite 8"(23.91%) and “Composite El-Bustan" (26.91%). Significant differences among studied genotypes indicated the presence of variability and it may be attributed to the different responses to produce onion from sets with higher or lower percentage of double bulbs and provide chance for improvement to produce genotypes with lower percentage of doubles bulbs percentage. Similar findings were found by Farrag and Koriem (1990), Shalaby *et al* (1991a, b and c), Koriem and Farrag (1996), Koriem *et al* (1996), Islam *et al* (1999) Seetohul and Hanoomanjee(1999), Khokhar *et al* (2002) and Dwivedi *et al* (2017).

Table 5. Means of individual season and combined across seasons for bolter bulbs, double bulbs% and Small bulbs% of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Genotype	Bolter bulbs%			Double bulbs%			Small bulbs%		
	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.	2014/015	2015/016	Comb.
Z 218 white	7.34 ef	72.10 bcd	39.72 def	58.01 bcd	15.95 a	36.98 abc	9.27 bcd	1.20 e	5.23 cde
T.E.Y.G x Giza 20	36.72 a	74.96 bcd	55.84 a	34.35 e	11.81 abc	23.08 f	15.49 a	3.67 cde	9.58 b
Giza 20 x Ori	8.17 ef	74.69 bcd	41.43 cdef	56.36 bcd	11.13 abcd	33.74 abcd	11.55 abc	6.05 bcde	8.80 bc
Composite El-Bustan	28.72 ab	74.12 bcd	51.42 ab	47.47 de	6.35 cde	26.91 def	5.04 def	8.49 abc	6.77 bcd
Giza 20 Nucleus	11.12 ef	78.28 abc	44.70 bcde	67.09 abc	9.96 abcde	38.52 ab	7.19 bcdef	2.77 de	4.98 cde
Behairy 1866	23.53 bcd	75.30 bcd	49.41 abc	53.98 cd	7.53 cde	30.76 bcdef	7.87 bcde	6.00 bcde	6.93 bcd
Giza 6 D.M.R	6.55 f	89.45 a	48.00 abcd	73.86 ab	4.34 e	39.10 ab	5.55 def	1.65 e	3.60 de
Giza 6 Mohassan oblong	14.54 cdef	80.59 abc	47.56 abcd	67.84 abc	9.82 abcde	38.83 ab	1.96 f	3.34 cde	2.65 e
Composite 8	26.16 abc	62.96 de	44.56 bcde	33.54 e	14.28 ab	23.91 ef	3.20 ef	7.19 bcd	5.20 cde
Composite 12	13.95 def	55.43 e	34.69 fg	47.65 de	9.98 abcde	28.81 cdef	8.10 bcde	9.22 ab	8.66 bc
Composite 18	5.15 f	52.64 e	28.90 g	54.26 cd	15.46 a	34.86 abcd	8.88 bcde	3.20 cde	6.04 bcde
Composite 16	3.74 f	84.78 ab	44.26 bcde	52.33 cd	4.85 de	28.59 cdef	12.89 ab	1.24 e	7.06 bcd
Puss p.r.r.	3.03 f	71.28 cd	37.16 ef	58.75 bcd	11.94 abc	35.35 abcd	8.78 bcde	5.48 bcde	7.13 bcd
Shandaweel 1	19.39 bcde	75.61 bc	47.50 abcd	58.25 bcd	7.99 bcde	33.12 abcde	6.11 cdef	7.31 bcd	6.71 bcd
Giza 6 Mohassan	6.69 f	77.71 abc	42.20 cdef	58.87 bcd	9.75 abcde	34.32 abcd	10.04 bcd	6.04 bcde	8.04 bc
Giza Red	6.42 f	83.74 abc	45.08 bcde	77.05 a	6.65 cde	41.85 a	8.67 bcde	1.37 e	5.02 cde
Giza 20	4.68 f	78.05 abc	41.37 cdef	76.47 a	4.47 e	40.47 a	16.38 a	12.64 a	14.51 a
F test at 0.05	*	*	*	*	*	*	*	*	*

A value followed by a letter common are not significant different from each other at P=0.05 according to Duncan' s multiple range test, *=Significant at p=0.05

Small bulbs Percentage

Data of percentage of small bulbs are presented in Table 5. Results indicated significant differences among the tested genotypes during each season and combined across seasons. In the first season genotypes "Giza 20", "T.E.Y.G x Giza 20", "Composite 16" and "Giza 20 x Ori" gave the highest percentage of small bulbs (16.38, 15.49, 12.89 and 11.55%, respectively),but, the lowest values were observed with genotypes "Giza 6 oblong"(1.96%) and "Composite 8"(3.20%). In the second season, genotypes "Giza 20", "Composite 12"and "Composite El-Bustan" recorded the highest percentage of small bulbs (12.64, 9.22, 8.49%, respectively), while genotypes "Z 218 white", "Composite 16","Giza Red" and "Giza 6 D.M.R" showed the lowest percentage (1.20, 1.24, 1.37 and 1.65%, respectively).

Data of combined analysis showed that genotype "Giza 20" produced the highest percentage of small bulbs (14.51%). Meanwhile, genotypes "Giza 6 oblong" and "Giza 6 D.M.R" recorded the lowest percentage (2.65 and 3.60%, respectively).These results indicated the presence of variability among genotypes and the variation might be attributed to their genetic background. Results are in harmony with those reported by Farrag and Koriem (1990), Koriem and Farrag (1996) and Koriem *et al* (1996).

Total weight loss of bulbs percentage

Data on total weight loss were illustrated in Table 6. Significant differences were detected among evaluated genotypes in both seasons as well as for combined data. In the first season, genotypes "T.E.Y.G x Giza 20" showed the highest percentage of total bulbs weight loss (43.95%) whereas, the lowest percentage of total bulbs weight loss was obtained by genotypes "Giza 6 Mohassan" cv.(14.70%) followed by "Giza Red" cv.(14.73%) and "Composite 16" (14.86%). In the second season genotypes "Composite 16", "Giza 6 D.M.R" and "Shandaweel 1" recorded the highest total weight loss of bulbs (9.35, 9.14 and 8.49%, respectively). Meanwhile, genotypes "Composite 18","Composite 12" and "T.E.Y.G x Giza 20" exhibited the lowest values (4.17, 5.30 and 5.56%, respectively).

Combined analysis revealed that genotype "T.E.Y.G x Giza 20" gave the highest value (24.75%) while, the lowest values of total bulbs weight loss%. were recorded by genotypes "Giza Red" (11.35%),"Giza 6 Mohassan" (11.42),"Puss p.r.r."(11.62%),"Composite 16" (12.10%), "Composite 12" (13.08%) and "Shandaweel 1" (13.18%). Former results have been reported by Morsy *et al* (2011), who evaluated seven onion genotypes grown from seedlings and found high significant variation among the evaluated varieties for weight loss percentage after storage period for 60 days, Beth Alpha cv. recorded the highest weight loss (40.06%) and (39.12%) in both seasons, respectively, meanwhile, "Giza 20" cv. showed the lowest values (9.79 and 9.34% in both seasons, respectively).

Table 6. Means of individual season and combined across seasons for total bulbs weight loss% of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Genotype	Total bulbs weight loss%		
	2014/015	2015/016	Comb.
Z 218 white	20.55 cdef	6.97 cdef	13.76 bc
T.E.Y.G x Giza 20	43.95 a	5.56 fg	24.75 a
Giza 20 x Ori	25.78 bcde	6.73 cdef	16.26 bc
Composite El-Bustan	20.55 cdef	6.77 cdef	13.66 bc
Giza 20 Nucleus	31.49 b	6.41 def	18.95 b
Behairy 1866	21.21 bcdef	6.71 cdef	13.96 bc
Giza 6 D.M.R	28.69 bcd	9.14 ab	18.91 b
Giza 6 Mohassan oblong	22.30 bcdef	8.17 abcd	15.24 bc
Composite 8	24.15 bcdef	6.20 ef	15.18 bc
Composite 12	20.85 bcdef	5.30 fg	13.08 c
Composite 18	29.32 bc	4.17 g	16.75 bc
Composite 16	14.86 f	9.35 a	12.10 c
Puss p.r.r.	15.80 ef	7.44 bcde	11.62 c
Shandaweel 1	17.86 def	8.49 abc	13.18 c
Giza 6 Mohassan	14.70 f	8.14 abcd	11.42 c
Giza Red	14.73 f	7.97 abcde	11.35 c
Giza 20	21.64 bcdef	7.94 abcde	14.79 bc
F test at 0.05	*	*	*

A value followed by a letter common are not significant different from each other at P=0.05 according to Duncan' s multiple range test, *=Significant at p=0.05

Genetic Parameters

Genotypic coefficient of variation (GCV), phenotypic coefficients of variation, broad sense heritability ($h^2{}_{b)}$ genetic advance (GA) and genetic advance as percentage of mean (GAM) for the studied traits are given in Table 7. GCV ranged from 9.35% for plant height to 70.43% for percentage of bolter bulbs in first season and ranged from 3.20% for plant height to 54.86% for small bulbs percentage in second season.

Table 7. Estimates of genotypic (GCV%) and phenotypic (PCV%) coefficient of variations and the difference between them, (D^z) broad sense heritability h^2_b, genetic advance(GA) and genetic advance as percent of mean (GAM) for growth characters of seventeen onion genotypes evaluated for onion production from sets during 2014/015 and 2015/016 seasons.

Character	2014/2015						2015/2016					
	GCV%	PCV%	D^z	h^2_b (%)	GA	GAM (%)	GCV %	PCV (%)	D^z	h^2_b (%)	GA	GAM (%)
Plant height	9.35	10.07	0.72	86	13.80	17.91	3.20	5.15	1.95	39	3.18	4.10
Number of leaves/plant	10.52	12.09	1.57	76	2.27	18.88	7.48	11.29	3.81	44	1.17	10.22
Total yield (t/fed)	17.85	18.80	0.94	90	5.89	34.99	15.49	16.76	1.27	85	4.15	29.54
Culls yield (t/fed)	16.85	18.44	1.59	83	4.21	31.75	17.31	18.46	1.15	88	4.13	33.47
Marketable yield (t/fed)	12.18	17.57	5.39	48	25.85	17.42	10.68	16.83	6.15	40	18.49	13.99
Bolter bulbs%	70.43	76.06	5.63	86	17.88	134.53	11.92	12.96	1.04	85	16.79	22.62
Double bulbs%	19.93	22.08	2.14	82	21.32	37.13	32.15	38.13	5.97	71	5.34	55.93
Small bulbs%	40.27	44.95	4.67	80	6.44	74.44	54.86	63.26	8.39	75	5.02	98.17
Total bulbs weight loss%	29.57	32.75	3.18	82	12.58	55.08	17.73	19.41	1.67	84	2.39	33.44

^{z} = The difference between genotypic (GCV %) and phenotypic (PCV %) coefficients of variation.

Phenotypic coefficient of variation PCV% ranged from 10.07% for plant height to 76.06% for bolters bulbs percentage in first season, meanwhile in second season PCV ranged from 5.15% for plant height to 63.26% for percentage of small bulbs. Sivasubraonanian and Menon (1973) suggested classification of PCV and GCV to three categories i.e. low ranged from 0 to 10%, moderate ranged from 11 to 20% and high for greater than 20%. Accordingly, plant height, number of leaves/plant were regarded as low GCV% and PCV% in both seasons, total yield, culls yield considered as moderate GCV% and PCV% in both seasons, Marketable yield and small bulbs% classified as high GCV% and PCV% in both seasons.

Whereas, percentage of bolter bulbs and total weight loss% showed high values of GCV% and PCV% in the first season and moderate values in the second one. Moreover, double bulbs percentage recorded medium value of GCV% percentage in the first season and high value in the second one, while PCV% values were high in both seasons. Narrow difference between PCV% and GCV% (D) was recorded for plant height, total yield and culls yield in both seasons indicated the presence of genetic variability and less environmental effects on such traits. Whereas, wide difference was observed for double bulbs% and small bulbs% in both seasons, indicated much effects of environment on such traits. Similar findings confirmed these results were detected by Dewangan and Sahu (2014), Aditika *et al* (2017), Dwivedi *et al* (2017) and Santra *et al* (2017) who reported low GCV% and PCV% for plant height and number of leaves/plant, Degewione *et al* (2011), Aditika *et al* (2017), Santra *et al* (2017) and Sharma *et al* (2017) concluded medium values of GCV% and PCV% for total yield, Morsy *et al* (2011) reported medium values of GCV% and PCV% for culls yield, Degewione *et al* (2011) and Dewangan and Sahu(2014) found high values of GCV% and PCV% for marketable yield, Degewione *et al* (2011) and Morsy *et al* (2011) concluded high values of GCV% and PCV% for total weight loss%**.**

As shown in Table 7, estimated PCV values were finally greater than GCV values it means that environment had an important role on the phenotypic expression and variability of these traits, the traits that had narrow difference between PCV and GCV such as plant height, total yield, marketable yield and culls yield, indicated the high genetic variability and lower environment variability and these traits are considered less sensitive to the influence of environmental factors. Burton (1952) reported that genotypic coefficient of variation along with heritability estimation provide a reliable estimates of the amount of genetic advance that could be expected with phenotypic selection, similarly Johnson *et al* (1955) reported that estimates of genetic advance is more useful tool when considered jointly with heritability estimates.

With regard to heritability in broad sense (h^2_b), Robinson *et al* (1951) categorized the values of (h^2_b) to low from o- 30%, moderate from 31-60% and greatest than 6o% as high. Based on such classification results indicated that, total yield, marketable yield, culls yield, percentage of bolters%, percentage of doubles bulbs%, percentage of small bulbs% and total weight loss% were the highest values of h^2_b in both seasons. Meanwhile, plant height, number of leaves per plant showed high values of (h^2_b) in first season and medium values in the second one. Such characters that had moderate to high estimates of (h^2_b) indicated the possibility of improving through selection. These results are in agreement with those obtained by Haydar *et al* (2007), Hosamani *et al* (2010), Degewione *et al* (2011), Dewangan and Sahu (2014), Aditika *et al* (2017), Dwivedi *et al*

(2017), Santra *et al* (2017) , Sharma *et al* (2017) and Singh *et al* (2017) who concluded high h^2_b for total yield. Degewione *et al* (2011), Dewangan and Sahu (2014), Santra *et al* (2017) and Sharma *et al* (2017) observed high h^2_b for marketable yield. Degewione *et al* (2011) found medium value of (h^2_b) for culls yield, Khosa and Dhatt (2013) noticed high value of h^2_b for bolter bulbs%, Degewione *et al* (2011) detected high value of h^2_b for total weight loss%. Mohanty (2001 and 2004), Morsy(2010), Degewione *et al* (2011), Dewangan and Sahu(2014), Aditika *et al* (2017), Dwivedi *et al* (2017), Sharma *et al* (2017) and Santra *et al* (2017) concluded high values of h^2_b for plant height and number of leaves/plant.

With respect to genetic advance (GA), estimated values ranged from 2.27 for leaves number /plant to 21.32 for double bulbs% in the first season, whereas, it was ranged from 1.17 for leaves number/plant to 16.79 for bolter bulbs% in the second season.

Concerning genetic advance as percentage of mean (GAM %) Falconer and Mackay (1996) suggested three categories for the values of genetic advance as percentage of mean , as low GAM% (range from zero to 10%), moderate GAM% (range from 11 to 20%) and high (greater than 20%).Therefore results showed that, total bulbs yield ,marketable yield, culls bulbs yield , percentage of bolter bulbs , percentage of double bulbs , percentage of small bulbs and percentage of total weight loss exhibited high values of GAM% in both seasons, Furthermore , plant height and number of leaves per plant recorded medium values of GAM% in first season and low values in the second one. These results are in accordance with those obtained by Mohanty (2001), Haydar *et al* (2007), Dewangan and Sah (2014), Aditika *et al* (2017), Dwivedi et *al* (2017), Sharma *et al* (2017) and Singh *et al* (2017) who reported medium GAM% for plant height and number of leaves/plant. Furthermore, Mohanty (2004), Hosamani *et al* (2010), Degewione *et al* (2011), Santra *et al* (2017) concluded low value for plant height, while Dewangan and Sahu(2014), Santra *et al* (2017) and Sharma *et al* (2017) found high values of GAM% for total and marketable yield. Degewione *et al* (2011) reported high value of GAM% for culls yield. Haydar *et al (*2007) found high value of GAM% for split bulbs% and Degewione *et al* (2011) detected high value of GAM% for total weight loss%. The high values of genetic advance are indicative of additive gene action, whereas low values refer to non-additive gene action controlled that traits, consequently heritability estimates will be reliable if accompanied with high genetic advance (Singh and Narayanan 1993). Hence traits such as total yield, marketable yield, culls yield, bolter, double, small bulbs percentage and total weight loss which showed high heritability coupled with high genetic advance are controlled by additive gene action and selection can therefore be effective for improving these characters.

CONCLUSION

It could be concluded that genotypes" Composite 12 " ,"Composite 8" and "composite 18" are considered the best genotypes for production onion from sets, because the first one showed the highest plant height , leaf no, total yield, marketable yield, culls yield, lowest bolters % and total bulbs weight loss %, similarly the second one recorded the highest plant height, marketable yield and lowest doubles % whereas, the third one was superior in marketable yield and had lower percentage of bolter bulbs. High to moderate heritability coupled with high to moderate genetic advance as percentage of means were observed for total yield, marketable yield, culls yield, bolters bulbs%, doubles bulb%, small bulbs% and total bulbs weight loss indicating that these traits are controlled by additive gene action and less affected by environment so, they could be improved through mass selection.

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تقييم وتقدير الثوابت الوراثية فى بعض التراكيب الوراثيه لانتاج البصل من البصيلات

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أجريت هذه الدراسة خلال الموسمين الزراعيين ٢٠١٥/٢٠١٤، ٢٠١٦/٢٠١٥ فى محطة بحوث الجيزه – معهد بحوث المحاصيل الحقليه – مركز البحوث الزراعية بهدف تقييم عدد ١٧ تركيب وراثى وذلك لأنتاج البصل من البصيلات وكذلك تقدير بعض الثوابت الوراثية الخاصة بصفات المحصول وجودة الأبصال والقدرة التخزينيه. أجريت التجربة باستخدام تصميم القطاعات كاملة العشوائية في ثلاثة مكررات. وأظهرت النتائج وجود اختلافات معنوية بين التراكيب الوراثية فى كل الصفات المدروسة حيث تفوقت التراكيب الوراثيه Composite 12 و Composite 8 و Composite 18 فى انتاج البصل من البصيلات حيث اظهر التركيب الوراثى الاول اعلى القيم فى صفات طول النبات وعدد الاوراق والمحصول الكلى والمحصول التسويقى ومحصول النقضه واقل نسبة فى الازهار الحولى والفقد الكلى بعد التخزين بينما اظهر التركيب الوراثى الثانى اعلى القيم فى صفة طول النبات والمحصول التسويقى و اقل فى نسبة الابصال المزدوجه و الأبصال ذات الأزهار الحولى(الحنبوط) بينما تميز التركيب الوراثى الثالث فى المحصول الصالح للتسويق وقلة نسبة الأبصال ذات الأزهار الحولى (الحنبوط). بالنسبه لمعامل الاختلاف الوراثى والمظهرى تراوحت القيم من معتدله الى عاليه لصفات المحصول الكلى والمحصول التسويقى ومحصول النقضه ونسبة الابصال المزدوجه ونسبة الابصال الصغيره ونسبة الفقد الكلى للابصال وطول النبات وعدد الاوراق.وكانت الفروق بين المعاملين صغيرة فى صفات طول النبات والمحصول الكلى ومحصول النقضه. بالنسبة لكفاءة التوريث فى المعنى العام وقيمة التحسين الوراثى المتوقع من الأنتخاب بالنسبه لمتوسط الصفه فقد تروح قيمها من متوسطه الى عاليه فى صفات المحصول الكلى والمحصول التسويقى ومحصول النقضه ونسبة الابصال الحنبوط ونسبة الابصال المزدوجه ونسبة الابصال الصغيره وكذالك نسبة الفقد الكلى للابصال وان ذلك يدل على ان هذه الصفات يتحكم فيها الفعل المضيف للجينات وعليه فان هذه الصفات تكون اقل تأثرا بالظروف البيئيه. بينما اظهرت صفات طول النبات وعدد الاوراق كفاءة على التوريث متوسطة مقترنة بقيمة منخفضة لنسبة التحسين الوراثى المتوقع بالأنتخاب وهذا يدل على ان هاتين الصفتين يتحكم فيها عوامل وراثيه غير مضيفه ويكون من الصعب التحسين فيها بأستخدام الانتخاب البسيط .وبناءا على ذلك يمكن استخدام التراكيب الوراثية Composite 12 وComposite8 و Composite 18 بغرض انتاج البصل من البصيلات كما يمكن اجراء الانتخاب لتحسين صفات المحصول الكلى والمحصول التسويقى ومحصول النقضه ونسبة الابصال الحنبوط ونسبة الابصال المزدوجه ونسبة الابصال الصغيره والفقد الكلى للابصال.

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