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FORAGE YIELD, QUALITY CHARACTERS AND GENETIC VARIABILITY OF SOME PROMISING EGYPTIAN CLOVER POPULATIONS

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ABSTRACT

The present study was conducted to evaluate eight berseem populations (selected for high forage yield) with five check cultivars and to estimate the relationships between yield, some growth parameters, quality characters, genetic variance, phenotypic variance, heritability, genotypic and phenotypic coefficient of variability in the experimental research station at Nubaria region, Al-Behira government across the two growing seasons 2015/2016 and 2016/2017. The results could be summarized from the combined analysis of the two seasons which indicated that the cultivar Helaly recorded the highest fresh and dry yield (71.065, 9.783 kg/plot) followed by the promising Pop.4 (70.579, 9.699 kg/plot) and Pop.6 (69.388, 9.683 kg/plot), respectively with insignificant differences. Helaly, Gemmiza- 1 and Pop.6 recorded the highest values of dry leaf/stem ratio with insignificant differences. The highest fresh leaf/stem ratio was obtained from Helaly, Pop.4 and Pop.6. While Pop.1 and Giza-6 recorded the lowest values of fresh and dry leaf/stem ratio. However, mean percentage of crude protein (CP %) and digestible crude protein (DCP %) were lower in Serw- 1 and Pop.1, while, Pop.46 and Gemmiza-1 recorded the highest values of CP% and DCP%. Helaly, Pop.46 and Gemmiza-1 gave the highest values of crude fiber (CF%) and ash%. Heritability was high for all traits studied. Fresh leaf/stem ratio showed the highest heritability (97.50%) followed by dry leaf/stem ratio (96.38%). A positive correlation was obtained between ash% with dry leaf/stem ratio and dry leaf/stem ratio (r = 0.87** and r = 0.86**), and between crude fiber with dry leaf/stem ratio and dry leaf/stem ratio (r = 0.90** and r = 0.84**). Besides, there was highly significant correlation between crude fiber% and ash% (r =-0.94**).The results reflected that Pop.4 and Pop.6 did not differ significantly from the commercial cultivar Helaly, and therefore it is recommended to multiply and use them in the breeding program to improve the productivity of Egyptian clover.

Key words: ***Egyptian clover (Trifolium alexandrinum L.), Genotypic and Phenotypic variance, Heritability, Genotypic and Phenotypic coefficient of variability.***

INTRODUCTION

The quality of forage can be described as the relative output of animals. Egyptian clover (Buxton *et al* 1996). In general, the requirements for better nutritional quality are higher levels of cell-soluble, crude proteins and minerals. With advanced plant growth, these forage components decrease dramatically and hit the lowest level as plants become high quality (Koc and Gokkus 1994) as in all step vegetation. The changing pattern of the forage nutritional variable shows great variations between types of range because the timing and duration of the growing season vary from the climate-related seasons (Holechek *et al 2004*). Most plants display a similarity between decreasing nutrients and advancing growth towards maturation (Robole *et al* 2004).

Every advancement in programmed breeding depends on the level of genetic variability in the population and the extent to which the desired features are heritable. In Egyptian clover, the approximate heritability in the broad sense (Bakheit 1986) reached 78 and 81 percent in Alexandria and Nubaria locations, respectively. Heritability in the broad sense was calculated by Ahmed (2000) as 92.56% for total green forage yield in berseem. Abd El-Galil and Hamed (2008) observed that in the broad sense of the seasonal fresh yield, heritability was high at 88.7%. In Egyptian clover, heritability in the broad sense was estimated by Rajab (2010) at 83.93% for fresh forage yield. Ahmed (1992) found for most cutting that heritability was 80% for fresh forage yield. Badawy (2013) studied recurrent selection in Helaly berseem clover for seed yield and found that fresh forage yield expressed the highest heritability estimates among characteristics in both family groups (64% and 75% for half-sib and S_1 families, respectively). However, the dry forage yield values obtained were of a lower magnitude (62% and 65% for half - sib and S_1 families, respectively). Abd El-Naby *et a*l (2014) recorded that heritability broad sense was extremely essential for Hatour x Fahl in terms of plant height and total fresh weight/ plant (90 and 84%, respectively). In the first season, where the highest values for fresh forage yield, dry forage yield and leaf/stem ratio were obtained, Ahmed et al (2015) calculated broad sense heritability on berseem clover at first cutting in the first season (98.23 , 98.7 and 100). Badawy (2017) suggested that a reusable genetic regulation, heritability for fresh forage yield achieved 69.56 percent.

El-Nahrawy *et al* (2006) estimated phenotypic diversity in certain cultivars of Egyptian clover under two locations for fresh forage yield. He found that the phenotypic coefficient of variance (P.C.V.) for the fresh forage yield of Egyptian clover was poor in all cuts. In 2003/2004, the reported values for successive cuttings at the Sakha site were 0.9, 6.9, 0.98 and 0.45 percent in the 2003/2004 season at the Sids venue, while they were 0.69, 0.70, 0.79 and 1.6 percent in 2004/2005. Rajab (2010) noted that for fresh forage yield, the highest P.C.V. was reported as 5.075 percent in 2001/2002, 9.036 percent in 2003/2004 and 6.792 percent in 2004/2005. Values for P.C.V. (4.75, 4.65, 1.22 and 3.07%) and for G.C.V. (3.21, 3.72, 0.77 and 2.24%), were recorded by Badawy (2017) for fresh yield, dry yield, plant height and dry leaf/stem ratio respectively.

The relationship among variables is evaluated by correlation analysis. Several workers have established a relationship between the characteristics of berseem clover (Ahmed 2000, Abdel Gawad 2003, Ahmed 2006, Abdel Galil 2007, Abo El-Goud *et al* 2015, Abd ElNaby *et al* 2015 and Radwan, *et al* 2015,).

This study aimed to evaluate eight promising genotypes of berseem along with five check cultivars, estimate the heritability for forage yield, study the genetic variability among different genotypes and identify the desirable traits for selection for high forage yield.

MATERIALS AND METHODS

The present study was conducted at the experimental farm of Nubaria Agricultural Research Station (which represents a Calcuries soil at North Egypt) during two successive seasons (2015/ 2016 and 2016/2017). Thirteen berseem (*Trifolium alexandrinum* L.) genotypes were used in this study (eight berseem populations and five check cultivars) (Table 1).

Table 1.Origin of the studied promising genotypes.

Genotypes	Origin
Pop.1, Pop.2, Pop.3 and Pop.4	**Populations selected from farmer's seed lots at Giza Station**
Serw-3	**Population selected under salinity condition from Serw-1 variety at Serw Agricultural Station.**
Pop.6, Pop.10 and Pop.46	**Populations selected from farmer's seed lots at Sakha Agricultural Station.**

The recommended cultural practices by the Forage Cops Department, Field Crop Res. Inst. ARC, for the calcareous soil, had been followed regarding soil preparation, NPK fertilization, irrigation and harvesting management during the two seasons. Soil samples were taken before sowing at 0-30cm and 30-60cm to determine soil physical and chemical characters for the two seasons (Table 2). The Sowing date was on 10^{th} and 4^{th} October in the two seasons, respectively. Seeds of each entry were drilled in plots (2×3m) during the two seasons with a rate of 20 kg/fad (30 g/plot) with equal distribution within each plot. The thirteen genotypes were randomly sown in a randomized complete block design with four replicates. Four cuts were harvested, the first after 55 days from planting and the following cuts were taken at about 30-35 days as cutting intervals.

Table 2. Soil physical and chemical properties of the experimental site of the Nubaria Agriculture Research Station Farm (Mean values across two years).

Characteristics	Soil depth	
	0-30 cm	30-60 cm
Texture	**Sandy loam**	**Sandy loam**
pH	**8.31**	**8.34**
Soil past extract:		
EC (dS/m)	**1.92**	**2.41**
Cations (meq/L)		
Ca^{2+}	**5.26**	**6.12**
Mg^{2+}	**2.20**	**2.02**
K^{+}	**1.63**	**1.63**
Na^{+}	**10.11**	**14.33**
Anions (meq/L)		
CO_3^{2-}	**-**	**-**
HCO_3^{-}	**3.66**	**2.75**
CL^{-}	**11.41**	**15.22**
SO_4^{2-}	**4.13**	**6.13**
Total CaCO3 (%)	**20.91**	**22.20**
O.M (%)	**0.41**	**0.39**
C.E.C.(meq/100)	**11.02**	**11.88**
Total N (%)	**0.030**	**0.027**
Available P(mg/kg)	**3.92**	**3.86**
Exchangeable K(mg/kg)	**96.4**	**93.5**

The studied traits

Plant growth characters

1- Plant height (cm): Ten guarded random plants were taken from each plot at cutting to determine the Plant height.

2- Fresh leaf/stem ratio: A sample of 200 g/plot for every fresh cutting was taken and separated to leaves and stems. Each component was weighed immediately to estimate the fresh leaf/stem ratio.

3- Dry leaf/stem ratio: Reweighed fresh samples after drying in an oven at 105ºc until a constant weight and the dry leaf/stem ratio was calculated.

Forage Yield

1. **Fresh forage yield (kg/plot):** The cut of each plot was immediately weighed as a fresh forage yield (kg/plot).
2. **Dry forage yield (kg /plot):** Samples of about 250 g had been taken from each plot and weighed immediately, then dried in an oven at 105ºC till a constant weight. The dry forage yield (Kg/ plot) was calculated by multiplying "dry matter percentage x fresh forage yield".

Quality characters:

Four cuts were obtained during each of the two growing seasons. The first cut was obtained after 55 days from sowing to insure the enough carbohydrates in the roots. However, the second cut was obtained after 35 days from the first one, the third cut was taken after 33days from the second one. Fourth cut was taken at 30 days from the third one. Ten plants were randomly selected from each experimental plot for four cuts in each of the two seasons to determine the following traits:

1) Crude protein (CP%): Total nitrogen content was determined according to the modified micro Kjeldahel method. Crude protein% was estimated by multiplying nitrogen percentage by 6.25 (A.O.A.C. 1990).

2) Crude fiber (CF%): Crude fiber (%) was determined according to (A.O.A.C. 1990)

3) Ash (%): Accurate weight of 2g of weighed samples of the separated leaves (about 2000mg) were dried using an air forced drying oven at 75°c till a constant weight. Samples were dried in a labeled Kraft paper bags which were laid in an air forced drying across the drying period. Dried samples were then cooled at room temperature, then ground finely and screened through hummer mill of 40 michs. The screened fine grounded samples were kept in sealed labeled plastic bags and stored in the refrigerator at 5°C till needed for the chemical analysis. Dried samples of each two replicates for each treatment were thoroughly analyzed according to A.O.A.C. (1990)

Quality analysis was conducted and presented on dry matter basis after preparing and drying the fresh forage samples which were randomly taken from each experimental unit where leaves of plants were separated to be chemically analyzed. Accurately, the dried composite samples re-dried for each treatment were put in weighed labeled-crucibles and placed in a muffle furnace at 600°C for about 6 hours, then cooled down to room temperature and waited till a constant weight (A.O.A.C., 1990).

4) Digestible crude protein (DCP %):

The digestible crude protein percent was determined according to Mcdonald *et al* (1978) and calculated as follows:

DCP% = [(CP X 0.9115) - 3.62]

Statistical Analysis

Data were subjected to the analysis of variance all according to Steel *et al* (1997) using SAS program (2014).Homogeneity test was performed on mean squares of errors for all genotypes before performing combined analysis of variance when it was homogenous according to Barttlet (1937). The genotypic (σ^2g) and phenotypic (σ^2p) variance were calculated according to Steel *et al* (1997) as shown in Table (3). Heritability estimate in broad sense (H) = (σ^2g/σ^2p) x100 was calculated as given by Hallauer *et al* (2010). Genotypic (G.C.V.%) and phenotypic (P.C.V.%) coefficients of variability were calculated according to Burton (1952). Simple correlation coefficient was calculated as described by El-Nakhlawy (2010).

Table 3. The form of the combined analysis of variance across two years.

Source of variation	d.f.	Mean square	E.M.S.
Year	y-1		
Replication within year	y(r-1)		
Genotype	g-1	M3	$\sigma^2e + r\sigma^2gy + ry\sigma^2g$
Genotype x year	(y-1)(g-1)	M2	$\sigma^2e + r\sigma^2gy$
Error	y(r-1)(g-1)	M1	σ^2e

Where: y, r, g are number of years, replications and genotypes, respectively. σ^2e, σ^2g, σ^2gy are error variance, genotypic variance and genotype x year variance, respectively.

RESULTS AND DISCUSSION

The combined analysis of variance for the studied traits was presented in Tables (4, 5). The results of the analysis of variance showed significant differences among genotypes for all traits. Highly significant interaction between genotypes x years for fresh forage yield, dry forage yield and plant height indicated that the genotypes responded differently from year to year and it is necessary to evaluate genotypes for a number of years (Bakheit 1986).

Table 4. Mean squares of combined analysis of variance for the traits of thirteen genotypes in multi-cut Egyptian clover across two years.

SOV	df	Plant height	Fresh leaf/ stem ratio	Dry leaf/ stem ratio	Fresh yield	Dry yield
Year	1	1131.75	84.352	91.116	6.55.33	4.591
Replication/year	6	9.144	1.440	2.037	15.211	1.388
Genotype	12	15.885**	48.603**	52.212**	195.636**	6.116**
Genotype x year	12	1.769**	1.392 NS	2.013 NS	37.214**	1.082**
Error	72	0.646	1.033	1.774	8.475	0.421

NS. Not significant. ** Significance at 0.01 probability level.

Table 5. Mean squares of combined analysis of variance for the quality traits of thirteen genotypes in multi-cut Egyptian clover across two years.

SOV	df	Crude protein (%)	Crude fiber (%)	Ash (%)	DCP (%)
Year	1	192.855	88.465	203.356	1138.402
Replication/ year	6	2.638	1.481	3.514	12.101
Genotype	12	9.127**	8.841**	8.430**	14.313**
Genotype x year	12	1.107**	1.049**	2.801**	1.809**
Error	72	0.141	0.264	1.092	0.170

**** Significance at 0.01 probability levels. DCP:**

Generally, if the variance of genotypes was higher than the interaction between genotypes x years, it is possible to possess great genetic variability about the amount of improvement through selecting superior genotypes. These results are in agreement with El- Nahrawy (1980), Radwan and Abou El-Fittoh (1983), Ahmed (2006), Abdel –Galil (2007), El Nahrawy (2007), Bakheit (2013), Radwan *et al* (2015), Abo-El-Goud *et al* (2015) and Badawy (2017).

Growth characters

I- Plant height:

Data in Table (6) showed that there were highly significant differences for plant height (cm) among genotypes of Egyptian clover. Helaly, Pop.4 and Pop.6 were the tallest in average of plant height with non-significant differences among them. While, Pop.3 had the lowest plant height. These results are in harmony with Badawy *et al* (2018) who recorded that Helaly gave the highest plant height.

Table 6. Means of plant height (cm) for thirteen genotypes of multi-cut Egyptian clover across two seasons of 2015/2016 and 2016/2017and combined data.

Genotypes	2015/2016					2016/2017					Combined data				
	Cut1	Cut2	Cut3	Cut4	Meam	Cut1	Cut2	Cut3	Cut4	Mean	Cut1	Cut2	Cut3	Cut4	Mean
Pop.1	69.24	64.92	70.50	75.74	70.10	71.43	67.00	77.92	72.82	72.29	70.33	65.96	74.21	74.28	71.19
Pop.2	69.30	67.63	72.25	76.52	71.42	71.49	69.71	68.70	73.60	70.87	70.39	68.67	70.47	75.06	71.14
Pop.3	68.51	64.23	66.51	78.01	69.31	70.70	66.31	80.19	71.19	72.09	69.60	65.27	73.35	74.60	70.70
Pop.4	68.26	68.66	69.75	80.75	71.85	70.45	70.84	82.93	73.93	74.53	69.35	69.75	76.34	77.34	73.19
Serw3	68.35	66.30	71.25	78.26	71.04	70.44	68.48	80.44	73.34	73.17	69.39	67.39	75.84	75.80	72.10
Pop.6	71.25	64.62	73.00	78.01	71.72	73.43	66.81	80.19	74.19	73.65	72.34	65.71	76.59	76.10	72.68
Pop.10	68.25	70.91	68.00	75.74	70.72	70.44	73.09	77.92	73.92	73.84	69.36	72.00	72.96	74.83	72.28
Pop.46	69.50	64.18	69.25	78.76	70.42	71.69	66.36	80.94	72.94	72.98	70.60	65.27	75.09	75.85	71.70
Helaly	68.24	70.38	72.03	78.02	72.16	70.33	72.56	80.20	73.20	74.07	69.37	71.56	76.19	75.69	73.19
Sakha 4	67.75	65.95	71.01	76.76	70.36	69.94	68.13	78.94	74.85	72.96	68.84	67.04	74.97	75.80	71.66
Serw 1	71.75	68.67	68.31	78.00	71.68	73.84	70.85	80.18	73.86	74.68	72.79	69.76	74.24	75.93	73.18
Gemmiza 1	71.75	67.84	70.25	77.50	71.83	73.85	70.02	79.68	74.01	74.39	72.80	68.93	74.96	75.75	73.11
Giza 6	67.25	69.71	69.24	79.78	71.49	69.43	71.89	81.96	73.67	74.23	68.34	70.80	75.60	76.72	72.86
Mean	69.18	67.23	70.10	77.83	71.72	71.34	69.38	79.24	73.50	73.36	70.26	68.30	74.21	75.66	72.10
$LSD_{0.05}$					1.04					1.57					1.32

2-Fresh leaf / stem ratio:

The results in Table (7) indicated that the mean of fresh leaf/stem ratio showed highly significant differences among all genotypes. Helaly was the highest one for fresh leaf/stem ratio followed by Pop.6 and Pop.46. While, Pop.1 and Giza-6 recorded the lowest values. This trait is very important for forage crops, which indicate palatability and nutritional quality of forage, also for breeding programs. These results are in agreement with Abd EL-Galil (2007) and El Nahrawy (2007), who showed that in Egyptian clover highly significant differences were obtained among genotypes , seasons and locations, as well as, Helaly had the highest fresh leaf /stem ratio (60.80) followed by Sakha- 4 (58.63). These results are also in agreement with those obtained by Abdalla and Abd EL- Naby (2013) and Badawy (2013).

Table 7. Means of fresh leaf/stem ratio for thirteen genotypes of multi-cut Egyptian clover across two seasons of 2015/2016 and 2016/2017and combined data.

Genotypes	2015/2016					2016/2017					Combined data				
	Cut1	Cut2	Cut3	Cut4	Mean	Cut1	Cut2	Cut3	Cut4	Mean	Cut1	Cut2	Cut3	Cut4	Mean
Pop.1	43.1	44.3	50.6	60.4	49.6	45.0	46.2	52.5	62.3	51.5	44.0	45.2	51.5	61.3	50.5
Pop.2	42.6	46.2	52.1	62.7	50.9	44.5	48.1	54.0	64.6	52.8	43.5	47.1	53.0	63.6	51.8
Pop.3	42.7	47.1	54.0	62.5	51.5	44.6	49.0	55.9	64.4	53.5	43.6	48.0	54.9	63.4	52.4
Pop.4	44.1	48.5	56.2	64.6	53.3	46.0	50.4	58.1	66.5	55.2	45.0	49.4	57.1	65.5	54.2
Serw3	41.4	47.8	54.2	64.2	51.9	43.3	49.7	56.1	66.1	53.8	42.3	48.7	55.1	65.1	52.8
Pop.6	46.2	50.4	58.0	66.7	55.3	48.1	52.3	59.9	68.6	57.2	47.1	51.3	58.9	67.6	56.2
Pop.10	43.5	47.8	54.6	65.0	52.7	45.4	49.7	56.5	66.9	54.6	44.4	48.7	55.5	65.9	53.6
Pop.46	44.3	49.7	56.2	67.4	54.4	46.2	51.6	58.1	69.3	56.3	45.2	50.6	57.1	68.3	55.3
Helaly	47.8	51.4	57.6	68.6	56.3	49.7	53.3	59.5	70.5	58.2	48.7	52.3	58.5	69.5	57.2
Sakha 4	44.5	48.6	55.3	66.3	53.6	46.4	50.5	57.2	68.2	55.6	45.4	49.5	56.2	67.2	54.5
Serw 1	44.4	48.3	55.1	66.1	53.1	48.3	50.2	59.0	70.0	55.4	45.3	49.2	56.0	67.0	54.3
Gemmiza 1	47.2	50.3	55.4	66.1	54.7	49.1	52.5	52.8	64.3	56.6	48.1	51.2	56.3	67.1	55.6
Giza 6	40.7	44.6	50.9	62.4	49.6	42.6	46.5	57.3	68.0	51.5	41.6	45.5	51.8	63.3	50.5
Mean	44.0	48.0	54.6	64.8	52.8	46.0	50.0	56.6	66.9	54.7	44.9	48.9	55.5	65.7	53.7
$LSD_{0.05}$					0.408					0.461					0.417

3- Dry Leaf /stem ratio:

Regarding to Table (8), the means of dry leaf/stem ratio showed highly significant differences among all genotypes. Helaly, Gemmiza-1 and Pop. 6 gave the highest values (67.3, 67 and 66.9), respectively with non-significant differences between them while Pop. 1 was the lowest (59.6). This trait is very important for evaluating forage crop, which indicate to quality for fresh yield, also for breeding program in Egyptian clover. These results are in agreement with those obtained by Abdalla and Abd El-Naby (2013) and Badawy (2017).

Table 8. Means of dry leaf/stem ratio for thirteen genotypes of multi-cut Egyptian clover across two seasons of 2015/2016 and 2016/2017and combined data.

Genotypes	2015/2016					2016/2017					Combined data				
	Cut1	Cut2	Cut3	Cut4	Mean	Cut1	Cut2	Cut3	Cut4	Mean	Cut1	Cut2	Cut3	Cut4	Mean
Pop.1	53.8	57.5	58.3	65.4	58.7	55.6	59.3	60.1	67.2	60.5	54.7	58.4	59.2	66.3	59.6
Pop.2	54.5	58.8	60.4	69.5	60.8	56.3	60.6	62.2	71.3	62.6	55.4	59.7	61.3	70.4	61.7
Pop.3	56.3	60.2	61.4	69.1	61.7	58.1	62.0	63.2	70.9	63.5	57.2	61.1	62.3	70.0	62.6
Pop.4	58.2	61.4	64.5	71.6	63.9	60.0	63.2	66.3	73.4	65.7	59.1	62.3	65.4	72.5	64.8
Serw3	57.1	59.3	63.7	70.4	62.6	58.9	61.1	65.5	72.2	64.4	58.0	60.2	64.6	71.3	63.5
Pop.6	61.5	63.2	66.3	73.9	66.2	62.1	63.8	66.9	74.5	66.8	62.2	63.9	67.0	74.6	66.9
Pop.10	57.4	59.3	63.2	71.3	62.8	59.2	61.1	65.0	73.1	64.6	58.3	60.2	64.1	72.2	63.7
Pop.46	58.2	62.4	64.2	73.8	64.6	60.0	64.2	66.0	75.6	66.4	59.1	63.3	65.1	74.7	65.5
Helaly	62.1	64.1	66.4	74.1	66.6	63.9	66.0	68.3	76.0	68.5	63.0	65.1	67.4	75.1	67.3
Sakha 4	61.3	60.7	63.4	72.6	64.5	61.1	60.5	63.2	72.4	64.3	62.2	61.6	64.3	73.5	65.4
Serw 1	57.7	59.5	61.8	69.5	62.1	59.5	61.3	63.6	71.3	63.9	58.6	60.4	62.7	70.4	63.0
Gemmiza 1	60.4	63.7	64.2	72.1	65.1	62.2	59.5	66.1	73.9	66.9	62.3	65.6	66.2	74.0	67.0
Giza 6	55.4	57.3	60.2	68.3	60.3	57.2	59.1	62.0	70.1	62.1	56.3	58.2	61.1	69.2	61.2
Mean	57.9	60.5	62.9	70.8	63.0	59.5	61.6	64.4	72.4	64.6	58.9	61.5	63.9	71.8	64.0
$LSD_{0.05}$					0.48					0.57					0.51

II Forage yield

Fresh forage yield (kg/plot)

Data in Table (9) recorded that the mean of fresh forage yield (kg/plot) for the thirteen genotypes of multi-cut clover in the two years were highly significant, Helaly was the highest cultivar compared to other genotypes for total fresh forage yield with insignificant difference with Pop.6 and Pop. 4. While, Pop. 1 and Pop. 3 were the lowest for fresh forage yield significantly as shown in Table (9). These results are in agreement with Abd El-Naby *et al* (2015) and El Nahrawy (2007).

Table 9. Means of fresh yield (kg/plot) for thirteen genotypes of multi-cut Egyptian clover over two seasons of 2015/2016 and 2016/2017and combined data.

Genotypes	2015/2016					2016/2017					Combined data				
	Cut1	Cut2	Cut3	Cut4	Total	Cut1	Cut2	Cut3	Cut4	Total	Cut1	Cut2	Cut3	Cut4	Total
Pop.1	12.36	16.40	20.93	21.95	71.64	10.96	15.00	19.53	20.55	66.04	11.66	15.70	19.34	21.25	67.95
Pop.2	12.85	17.20	20.28	21.85	72.18	11.45	15.80	18.88	20.45	66.58	12.15	16.50	18.96	21.15	68.77
Pop.3	11.43	16.41	20.68	20.55	69.08	10.03	15.01	19.28	19.15	63.48	10.73	15.71	18.51	19.85	64.82
Pop.4	12.76	17.60	21.55	22.43	74.34	11.36	16.20	20.15	21.03	68.74	12.06	16.90	19.89	21.73	70.58
Serw3	12.02	17.18	21.71	21.22	72.11	10.62	15.78	20.31	19.82	66.51	11.32	16.48	19.36	20.52	67.67
Pop.6	13.37	17.43	21.23	21.45	73.47	11.97	16.03	19.83	20.05	67.87	12.67	16.73	19.24	20.75	69.39
Pop.10	13.22	16.42	20.52	21.72	71.89	11.82	15.02	19.12	20.32	66.29	12.52	15.72	19.02	21.02	68.29
Pop.46	11.02	17.13	22.23	21.48	71.85	9.62	15.02	20.83	20.08	66.25	10.32	16.43	19.75	20.78	67.28
Helaly	13.12	17.43	21.28	22.72	74.54	11.72	15.73	19.88	21.32	68.94	12.42	16.73	19.90	22.02	71.07
Sakha 4	11.93	15.92	19.96	17.98	71.79	11.53	16.02	19.56	17.58	67.19	13.23	17.22	18.87	19.28	68.60
Serw 1	12.84	17.32	21.84	20.91	72.92	11.44	15.52	20.44	19.51	67.32	12.14	16.62	19.28	20.21	68.25
Gemmiza 1	11.86	17.65	20.84	22.18	72.52	10.46	16.24	19.44	20.78	66.92	11.16	16.94	19.41	21.48	68.99
Giza 6	12.53	16.31	20.95	22.01	71.81	11.13	14.91	19.55	20.61	66.92	11.83	15.61	19.38	21.31	68.14
Mean	12.41	16.95	21.08	21.42	72.32	11.09	15.56	19.75	20.10	66.85	11.86	16.41	19.30	20.87	68.44
$LSD_{0.05}$					1.909					2.311					2.156

Dry forage yield (kg/plot):

Dry forage yield showed highly significant differences as presented in Table (10). Hellay recorded the highest dry forage yield with non-significant difference with Pop.4 and Pop.6. While, Pop.3 and Pop.1 recorded the lowest mean of dry forage yield. These results are in agreement with Abd El-Naby *et al* (2015) and El Nahrawy (2007). It is worthy to mention that Pop.4 and Pop.6 showed insignificant difference for fresh and dry forage yield compared with the commercial cultivar Helaly and were superior compared to other commercial cultivars Sakha- 4, Serw-1, Gemmiza-1 and Giza- 6.

Table 10. Means of dry yield (Kg/plot) for thirteen genotypes of multi-cut Egyptian clover over two seasons of 2015/2016 and 2016/2017 and combined data.

Genotypes	2015/2016					2016/2017					Combined data				
	Cut1	Cut2	Cut3	Cut4	Total	Cut1	Cut2	Cut3	Cut4	Total	Cut1	Cut2	Cut3	Cut4	Total
Pop.1	1.331	1.941	2.900	3.473	9.645	1.061	1.671	2.630	3.203	8.565	1.196	1.806	2.765	3.338	9.105
Pop.2	1.349	1.859	3.442	3.407	10.057	1.079	1.589	3.172	3.137	8.977	1.214	1.724	3.307	3.272	9.517
Pop.3	1.172	1.827	3.171	3.424	9.594	0.902	1.557	2.901	3.154	8.775	1.037	1.692	3.036	3.289	9.054
Pop.4	1.499	1.973	3.293	3.474	10.239	1.229	1.703	3.023	3.204	9.159	1.364	1.838	3.158	3.339	9.699
Serw3	1.259	1.947	3.457	3.192	9.855	0.989	1.677	3.187	2.922	8.775	1.124	1.812	3.322	3.057	9.315
Pop.6	1.197	2.026	3.564	3.436	10.223	0.927	1.756	3.294	3.166	9.143	1.062	1.891	3.429	3.301	9.683
Pop.10	1.396	1.898	3.333	3.250	9.877	1.126	1.628	3.063	2.980	8.797	1.261	1.763	3.198	3.115	9.337
Pop.46	1.195	1.932	3.145	3.424	9.696	0.925	1.662	2.875	3.154	8.616	1.06	1.797	3.010	3.289	9.156
Helaly	1.297	2.080	3.287	3.659	10.323	1.027	1.810	3.017	3.389	9.243	1.162	1.945	3.152	3.524	9.783
Sakha 4	1.308	2.015	2.38	3.514	9.226	1.038	1.745	3.119	3.244	9.146	1.173	1.580	3.254	3.379	9.686
Serw 1	1.223	1.939	3.383	3.596	10.141	0.953	1.669	3.113	3.326	9.061	1.088	1.804	3.248	3.461	9.601
Gemmiza 1	1.366	2.236	3.284	3.230	10.116	1.096	1.971	3.014	2.960	9.036	1.231	2.101	3.149	3.095	9.576
Giza 6	1.331	1.932	3.128	3.292	9.674	1.063	1.661	2.848	3.022	8.594	1.200	1.791	2.962	3.154	9.134
Mean	1.301	1.969	3.212	3.413	9.897	1.031	1.699	3.019	3.143	8.914	1.167	1.811	3.153	3.277	9.434
$LSD_{0.05}$					0.310					0.421					0.367

Such results are mainly due to the fact that photoperiod and soil temperature both affect growth rate, stem initiation, and allocation of photosynthetic products to the development of roots and stem (Buxton *et al* 1996). The warmer temperature and longer days cause more rapid plant development and greater cell wall lignification than that occurs in cooler temperatures (Holechek *et al* 2004).

The results showed that there were significant differences between genotypes for fresh and dry forage yields in combined analysis. The highest fresh and dry forage yield were recorded from Helaly followed by Pop.4 genotype. While, the lowest value of fresh and dry yield were recorded in Pop.3 and Pop.1.

These results are in agreement with Abd El- Naby *et al* (2015) and El –Nahrawy (2007) ,who evaluated 12 promising populations and indicated that new Khadrawy had the highest for total fresh yield (72.50 ton/fad) and exceeded significantly the highest cultivar Giza- 6 (67.5 ton/fad). Also, the results are in agreement with Abd EL-Galil (2007).

Quality characters

Results of crude protein (%), crude fiber%, ash (%) and digestible crude protein (DCP %) in the thirteen berseem genotypes are presented in Table (11). The statistical analysis indicated that there were significant differences among the tested genotypes in all cuts for all tested chemical characters.

Table 11. Means of Crude protein (%), Crude fiber(%), Ash (%)and DCP (%) for thirteen genotypes of multi-cut Egyptian clover across two seasons 2015/2016 and 2016/2017 and combined data.

Genotypes	Crude protein (%)			Crude fiber(%)			Ash (%)			DCP (%)		
	Y1	Y2	Comb.	Y1	Y2	Comb.	Y1	Y2	Comb.	Y1	Y2	Comb.
Pop.1	15.61	15.11	15.36	24.18	24.46	24.32	13.63	13.57	13.60	10.61	10.15	10.38
Pop.2	15.50	15.38	15.44	24.53	24.37	24.45	14.02	13.82	13.92	10.51	10.40	10.45
Pop.3	15.49	15.31	15.40	25.11	24.95	25.03	14.23	14.07	14.15	10.50	10.33	10.41
Pop.4	15.56	15.46	15.51	25.27	25.19	25.23	14.19	14.27	14.23	10.56	10.33	10.44
Serw3	15.75	15.69	15.72	25.12	24.96	25.04	14.20	14.06	14.13	10.74	10.68	10.71
Pop.6	15.90	15.86	15.88	25.87	25.69	25.78	14.35	14.11	14.32	10.87	10.84	10.85
Pop.10	16.28	16.18	16.23	25.62	25.40	25.51	14.30	14.26	14.28	11.19	11.13	11.16
Pop.46	16.96	16.88	16.92	26.44	26.24	26.34	14.56	14.44	14.50	11.84	11.77	11.80
Helaly	16.18	16.04	16.11	26.59	26.45	26.52	14.62	14.48	14.55	11.13	11.00	11.06
Sakha 4	15.96	15.92	15.94	25.50	25.48	25.49	14.32	14.24	14.28	10.91	10.89	10.90
Serw 1	15.08	14.94	15.01	26.10	25.94	26.02	14.45	14.35	14.40	10.12	10.00	10.06
Gemmiza 1	16.36	16.30	16.33	26.35	26.25	26.30	14.42	14.54	14.50	11.29	11.24	11.26
Giza 6	15.94	15.86	15.90	24.90	24.72	24.81	14.13	14.01	14.07	10.91	10.84	10.87
Mean	15.89	15.76	15.82	25.51	25.39	25.45	14.26	14.18	14.22	10.86	10.73	10.79
$LSD_{0.05}$			0.386			0.504			0.447			0.518

The genotype Pop.46 had the highest values of crude protein% and DCP% across all genotypes (16.92 and 11.80%) followed by Gemmiza-1 (16.33 and 11.26%) whereas Serw-1 recorded the lowest value (15.01 and 10.06%) across all genotypes. Crude fiber means ranged from 26.52% for Helaly to 24.32% for Pop.1. Data in Table (11) revealed that the highest content of Ash%, was recorded for Helaly followed by Pop.46 and Gemmiza-1 (14.55, 14.50 and 14.50%), respectively.

However, ash% ranged from 14.55 to 13.60% and crude fiber% ranged from 26.52 to 24.32% in Helaly and Pop.1, respectively. Helaly, Pop.46 and Gemmiza-1 had no significant differences for fiber and crude ash%, whereas Pop1 had lowest value for such trait. These results agreed with Abd El-Gawad (2003) and Abd El-Naby *et al* (2015). They suggested that, Helaly had the highest values of (CP%).

Genetic parameters

The genetic parameters (σ^2g, σ^2p, GCV%, PCV% and H%), as well as, grand mean are presented in Table (12). Wide ranges of variability for fresh forage yield and dry forage yield traits were detected. The high range of variation indicated that farmer's seed lots vary in productivity as a consequence of genetic variability (Bakheit 1986). The results showed that the environmental effect was limited, while the genotypic variance relative to phenotypic variance for all traits was high, indicating that the environmental effects were limited. The phenotypic coefficient of variance (P.C.V.%) varied from 1.937% for plant height to 9.006% for dry forage yield and genotypic coefficient of variation (G.C.V.%) was varied from 1.843% for plant height to 8.43% for dry forage yield. The high values of P.C.V.% and G.C.V. % for fresh forage yield indicate the possibility of improving it by phenotypic selection for the development of new populations. Narrow differences were obtained between (P.C.V. %) and (G.C.V.%) for all traits, suggesting some effects of environments on these traits due to its confounding by the genotype x year interaction. Also this reflected in higher estimates for heritability in broad-sense. These results are in agreement with Hill and Baylor (1983), Bakheit (1986 and 1989), Badawy (2013 and 2017), Abd EL-Galil (2007), Abd EL-Naby *et al* (2015) and Abo El- Goud *et al* (2015).

Heritability in broad sense was 97.50% for fresh leaf stem ratio, 96.38% for dry leaf stem ratio, 87.39% for fresh forage yield, 87.12% for dry forage yield, 92.86% for crude protein, 92.26% for crude fiber and 74.41% for ash%. These results indicated that these traits were less influenced by the environment and largely influenced by the genetic effects.

Table 12. Mean, genotypic and phenotypic variances, genotypic and phenotypic coefficient of variation and heritability in broad sense for various traits across two years in multi –cut Egyptian clover.

Character	Plant height (cm)	Fresh leaf/stem ratio	Dry leaf/stem ratio	Fresh yield (kg/plot)	Dry yield (kg/plot)	Crude protein (%)	Crude fiber (%)	Ash (%)
Mean	72.10	53.7	64.0	68.444	9.434	15.82	25.45	14.22
σ^2_e	0.646	1.033	1.774	8.475	0.421	0.141	0.264	1.092
σ^2_g	1.764	5.901	6.274	19.803	0.629	1.002	0.978	0.704
σ^2_{gxe}	0.426	0.089	0.059	7.184	0.165	0.241	0.196	0.427
σ^2_P	1.951	6.052	6.509	22.658	0.722	1.079	1.060	0.946
h^2%	90.41	97.50	96.38	87.39	87.12	92.86	92.26	74.41
GCV	1.842	4.523	3.905	6.501	8.406	6.327	3.885	5.900
PCV	1.937	4.581	3.978	6.954	9.006	6.566	4.045	6.839

σ^2_e: environmental variance, σ^2_g: genotypic variance.σ^2_{gxe} genotypic x environment variance, σ^2_P: phenotypic variance, P.C.V.: phenotypic coefficient of variability and G.C.V.: genotypic coefficient of variability.

These results are in agreement with Radwan and Abou El- Fittoh (1970) and Bakheit (1986) who estimated broad-sence heritability, from four experiments for multi-cut berseem green forage as 78% and 81% at Alexandria and Nubaria regions, respectively. Bakheit and Mahdy (1988) obtained values of broad-sence estimates for fresh forage yield of 87.3%. Ahmed (2006) had a value of 75.71 and 67.96% for plant height of “Meskawi” and "Khadarawi" populations, respectively. The selection is influenced largely, by the presence of additive genetic variance. The latter results is indicative of the magnitude of heritability and some other factors that was strongly supported by the findings of Hallauer *et al* (2010), Ahmed (2000), Ahmed (2006) and Ahmed *et al* (2017).

Correlation study

The presented data in Table (13) showed simple correlation coefficients between fresh forage yield, dry forage yield, plant height, fresh/leaf stem ratio ,dry leaf/stem ratio, crude protein (%), crude fiber (%) and ash (%).

Table 13. Simple correlation coefficients among traits in multi-cut Egyptian clover across two years.

Character	Fresh yield (kg/plot)	Dry yield (kg/plot)	Plant height (cm)	Fresh leaf/stem ratio	Dry leaf/stem ratio	Crude protein (%)	Crude fiber (%)	Ash (%)
Fresh yield (kg/plot)	1.00	0.81**	0.69**	0.49*	0.47	0.10	0.31	0.27
Dry yield (kg/plot)		1.00	0.58**	0.69**	0.66**	0.04	0.47	0.49*
Plant height (cm)			1.00	0.50*	0.49*	0.11	0.56**	0.57**
Fresh leaf/stem ratio				1.00	0.95**	0.46	0.90**	0.87**
Dry leaf/stem ratio					1.00	0.56**	0.84**	0.86**
Crude protein (%)						1.00	0.46	0.54*
Crude fiber (%)							1.00	0.94**
Ash (%)								1.00

*** and ** indicated significance at 0.05 and 0.01 probability levels, respectively.**

Positive and highly significant correlations were detected between fresh forage yield and dry forage yield (0.81**) and plant height (0.69**), also dry forage yield significantly and positively correlated with fresh leaf/stem ratio and dry leaf/stem ratio with r values equal 0.69** and 0.66**, respectively. Fresh leaf/stem ratio significantly and positively correlated with dry leaf/stem ratio (r=0.95**). These results indicated the importance of selection for such traits to obtain high productive synthetic varieties (Jatsara *et al* 1980, Bakheit, 1986 and 1989, Abd EL-Galil, 2007, and Radwan *et al* 2015). Moreover, the results showed highly significant correlation between ash% and both fresh leaf/stem ratio and dry leaf/stem ratio with values of 0.87** and 0.86**, respectively. Highly positive and significant correlation were found between crude fiber and fresh leaf/stem ratio (0.90**) and dry leaf/stem ratio (0.84**). Also, positive and highly significant correlation was recorded between fiber% and ash% (r=-0.94**). The obtained correlation results revealed the importance of the high significant correlation coefficients between the traits of Egyptian clover in using of selection for such traits to obtain high productive synthetic varieties. These results are in harmony with the results of Abd El-Naby *et al* (2014) and Abd El-Naby *et al* (2015) in berseem clover plants.

CONCLUSION

It can be concluded that, the two promising selected populations (Pop.4 and Pop.6) produced high fresh yield and dry yield besides high quality properties with non-significant differences from the best commercial cultivar (Helaly) in Nubaria region. So, they could be used at a commercial scale. Fresh and dry leaf / stem ratio and plant height traits significantly affected fresh and dry forage yields accordingly, they should be considered as selection criteria in berseem clover breeding program for improving forage yield production especially in the Nubaria region.

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المحصول العلفى و صفات الجودة و التباينات الوراثية لبعض العشائر المبشرة من البرسيم المصرى

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تم تقييم ثلاثة عشر تركيب وراثى من البرسيم المصرى, ثمانية من العشائر المبشرة (عشيرة 2,3,4,1, سرو3, 6,10,46) المنتخبة لمحصول العلف العالى مقارنة بخمس اصناف تجارية (هلالى, سخا4, سرو1, جميزة1, جيزة6). أجريت هذه الدراسة فى محطة البحوث الزراعية بالنوبارية خلال موسمى 2017/2016,2016/2015 لتقدير العلاقة بين المحصول وبعض صفات النمو وجودة المحصول وكذلك لتقدير كفاءة التوريث ودراسة التباينات الوراثية وتحديد الصفات المرغوبة لمحصول العلف بأستخدام معامل الارتباط والتعرف على أفضل العشائر المبشرة التى يمكن أدخالها فى برامج التربية. ولقد أظهرت النتائج مايلى: سجل الصنف هلالى اعلى وزن محصول أخضر وجاف بمتوسط (71.065 ،9.783 كجم/قطعه تجريبيه) يليه العشيرة المبشرة 4 بمتوسط (70.579، 9.699 كجم/قطعه تجريبية) يليه العشيرة المبشرة 6 بمتوسط (69.388، 9.683) بدون فارق معنوى ولقد اظهرت الاصناف هلالي وجميزة 1 وكذلك العشيرة المبشرة 6 أعلي نسبة وزن جاف للاوراق/السيقان بدون فروق معنوية وكذلك أظهرت النتائج تفوق لكل من هلالي والعشيرتين المبشرتين 4، 6 وبالنسبة لنسبة الوزن الأخضر للاوراق علي السيقان. بينما سجلت العشيرة 6 والصنف جيزة-1 اقل قيم في نسبة الوزن الأخضر والجاف للاوراق/السيقان. وسجل سرو 1 والعشيرة 1 اقل نسبة مئوية للبروتين وكذلك البروتين المهضوم، بينما اظهرت العشيرة 46 وكذلك الصنف جميزة1 اعلي نسبة مئوية للبروتين وكذلك البروتين المهضوم. وقد سجل الصنف هلالي وجميزة 1 والعشيرة 46 اعلي معدل من الالياف والرماد. كانت كفاءة التوريث عاليه لكل الصفات المدروسة حيث كانت (97.50%) لصفه نسبة الاوراق/السيقان (أخضر) و(96.38%) لنسبة الاوراق/سيقان (جاف). ولقد وجد معامل ارتباط عالى وموجب بين المحصول الاخضر والمحصول الجاف (0.81). ايضا يوجد علاقة ارتباط موجبه ومعنويه بين نسبة الاوراق/سيقان (أخضر) ونسبة الاوراق/سيقان (جاف) (0.95%) أيضا هناك علاقة ارتباط موجبه معنوية لنسبة الاوراق/سيقان (جاف) ومعدل الألياف والرماد حيث كان (0.84 ،0.86) علي التوالي وكذلك هناك علاقة ارتباط قويه بين نسبة الالياف والرماد (0.94). عكست نتائج هذه الدراسة أن العشيرة 4 لم تختلف معنويا عن الصنف التجاري هلالى وأيضا العشيرة رقم 6 ولذلك نوصى باكثارهم واستخدامهم فى برنامج التربيه لزيادة الأصناف التجارية المحسنه ولتحسين انتاجية البرسيم المصرى .

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