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FORAGE YIELD AND SEED SETTING OF SEVEN POPULATIONS OF EGYPTIAN CLOVER

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ABSTRACT

Egyptian clover (Trifolium alexandrinum L.), also known as berseem or clover, is one of the best annual crops for winter forage production Two years experiment was carried out at Agricultural Research Station in Giza during 2005-06 and 2006-07 seasons. Parents and three inbreeding generations (I_o, I_1, I_2), were used to estimate the relative changes due to increasing homozygosity on agronomic traits. Seven berseem populations of different geographical locations of Egypt were studied; five varieties (Giza-6, Sakha-4, Helaly, Gemmiza-1, Serw-1) and two newly developed populations (Hatour and Narmer). Fertility was recorded on bagged heads either manually tripped gently by fingers (MT) or for bagged heads left for spontaneous seed set (ST) and also for open-pollinated (OP) heads. The pooled analysis of variance showed that year effect was highly significant for tillers number. Results of the interaction between populations were significant only for forage and dry yields. Newly developed populations (Hatour and Narmer) showed superiority on all populations in all traits. Heritability percentage in broad sense was very high, ranged from 97.67 for plant height, 93.73 for number of tillers, 89.57 for forage yield and 89.89 for dry yield. High significant differences were observed among and within population for seed setting % in all modes of pollination. The first inbred generation varied from the five control populations. Developed populations yielded no sterile plants, but control populations recorded sterile plants in (MT). Similar reaction was observed in the I_2 of I_1 plants. High sterile percentage for manual tripping (MT) I_o plants was correlated with forage and dry yields of local populations. High correlation was found between seed setting % of OP (open pollinated) with I_1 and I_2 ($r\ I_1 = 0.942^{**}$ and $r\ I_2 = 0.955^{**}$) and between dry forage (kg fed^{-1}) with OP %($r = 0.8339^{**}$). Inbreeding depression (ID) of I_1 generation was differed from each population to another. Hatour and Narmer indicated no or less ID but Gemmiza-1, Giza-6 and Sakha-4 populations were more affected by ID in all traits.Hellaly and Serw-1 populations were more tolerant to ID. Crown and tillers distribution varied according to population. Breeder may select for self-fertile plants and then evaluating for high forage and dry yields to obtain better improved varieties.

Key words: ***Berseem, Egyptian Clover, Forage yield, Fertility, Seed setting, Sterility,Pollination, Inbreeding depression.***

INTRODUCTION

Egyptian clover (*Trifolium alexandrinum* L.), also known as berseem or clover, is one of the best annual crops for winter forage production (Graves *et al* 1996). It is considered as a high forage yield with good quality when cultivated alone or in mixtures to extend the harvest over several cuttings (Martiniello 1999). Improvement in forage yield is the objective of the

plant breeder; dependable yield of hay, green forage and seeds are economic necessity. Yield improvement can be the key to a successful livestock system. Meanwhile seed yield varies greatly from year to year and from location to location depending on environmental conditions as temperature, humidity, soil.....etc.

Berseem clover is a diploid (2n = 16) species, normally cross-pollinated by insects. Self-fertility may decrease with inbreeding, although many plants of berseem populations appeared to be highly self-fertile (Iannucci, 2001, 2004, Abd El-Naby 2003 and Abdalla *et al* 2008). Mehta *et al* (1964) found significant differences for fodder yield among different varieties of berseem. Gupta *et al* (1974) reported variation in forage yield among various berseem cultivars. Many authors noted that plant characters like height, leafiness and tillering had positive influence on green forage yield potential of berseem varieties (Yadav *et al* 1974, Beri and Sohoo 1985 and 1986, Chaudhry *et al* 1991 and Abdalla *et al* 2009).

Despite its importance as a forage crop, berseem clover has not been subjected to serious breeding work. Consequently, a breeding program has been undertaken to developing new varieties with stable and good yield and quality. In this concern Abdalla *et al* (2009) reported on developing two new berseem varieties (Hatour and Narmer) through inbreeding and selection in two berseem populations.

In this study, parents and three inbred generations of the two new varieties and five berseem populations of different geographical locations of Egypt were compared under three cutting treatments. The objective was to estimate the relative changes due to increasing homozygosity on agronomic traits to investigate the effectiveness of selfing on berseem.

MATERIALS AND METHODS

Two years experiment was carried out at Agricultural Research Station in Giza during 2005-06 and 2006-07 seasons.

Seven populations of Egyptian clover were compaired; Giza-6, Sakha-4, Helaly, Gemmiza-1, Serw-1 and two newly developed populations (Hatour and Narmer see Abdalla *et al* 2009) in RCBD with four replications. Each plot consisted of five rows of four meters long and 25 cm apart. Plots were irrigated after sowing (14 November) 2005-06 and (27 November) 2006-07 and after each cut throughout the growing seasons.For each cultivar four scheduled cuts were taken at 65, 95, 125, 155 days after sowing, and then plants were left to produce seeds.

Growth and yield characteristics measured were fresh and dry forage (DM%) yields, number of tillers per plant and plant height. Also

fertility was recorded on 50 insividual plants of two replications only for bagged heads either manually tripped gently by fingers (MT) or for bagged heads left for spontaneous seed set (ST) and also for open-pollinated (OP) heads. Data for the two growing seasons were statistically analyzed (Steel and Torrie 1984) using SAS software, while means were compared using Duncan multiple range test (Duncan 1955). Heritability was estimated according to Falconer (1981). Inbreeding depression (I.D.) measuring according to Liang, G.H., C.R.R. Ready and A.D. Dayton (1972). Inbreeding depression ($I.D_1$) % = $I_1 - I\,o / I\,o$ X 100.

RESULTS AND DISCUSSION

The pooled analysis of variance showed that year effect was highly significant for tillers number only. Populations differed significantly in all the four characters studied (Table 1). No effects were found of interactions between replications and populations over years. The interaction between populations was significant for forage and dry yields (Table 1).

Table 1. Significance of mean squares for plant height, No. tillers, fresh and dry matter yield, in seven berseem populations

S.O.V.	d.f.	Plant hieght	No. tillers	Fresh yield t. fed^{-1}	Dry yield kg fed^{-1}
Year (Y)	1	n.s	**	n.s	n.s
Replications (R)	3	*	*	n.s	n.s
Populations (P)	6	**	**	**	**
YxR	3	n.s	n.s	n.s	n.s
YxP	6	n.s	n.s	*	*
YxRxP	36	-	-	-	-

ns, *, **: not significant and significant at $p \leq 0.05$ and $p \leq 0.01$, respectively.

The newly developed Hatour and Narmer populations (specially Hatour) were more superior than all populations in all traits. Hatour indicated more number of tillers (33.62) followed by Narmer (31.62). Hellaly and Giza-6 populations showed good performance and may be improved by breeding. New methodology for improving local berseem population suggested by Abdalla *et al* (2009), may help to increase the unit

area production of forage and seeds. High forage and dry yield were produced by new developed populations (Hatour and Narmer) 68.18 t fed^{-1}, 1090.85 kg fed^{-1} and 61.96 t. fed^{-1}, 991.40 kg fed-1, respectively in total of three cuts. The populations Hatour, Narmer, Hellaly and Giza-6 significantly performed better than all other populations in all traits (Table 2). These populations were derived and developed from multi-cut miskawi berseem.

Table 2. Combined mean plant height, number of tillers, forage and dry yield of different populations of berseem over two seasons (2005-06/2006/07).

Population	Plant height cm	No. tillers	Fresh yield t.fed^{-1}	Dry yield kg fed^{-1}
Gemmiza-1	71.37 ^{d}	25.00 ^{d}	45.25^{e}	724.00 ^{e}
Giza-6	78.62 ^{c}	28.37 ^{c}	54.87 ^{d}	878.00 ^{cd}
Hatour	86.00 ^{a}	33.62 ^{a}	68.18 ^{a}	1090.85 ^{a}
Hellaly	81.12 ^{b}	29.75 ^{c}	57.44 ^{c}	919.12 ^{c}
Narmer	81.12 ^{b}	31.62 ^{b}	61.96 ^{b}	991.40 ^{b}
Sakha-4	78.75 ^{c}	26.62 ^{c}	53.00 ^{d}	848.00 ^{c}
Serw-1	67.12 ^{e}	20.87 ^{e}	41.25 ^{f}	660.00 ^{f}
Mean	77.73	27.98	54.57	873.05
Heritability%	97.67	93.73	89.57	89.89

Values within a column for each principal factor not followed by the same letter are significantly different at $p \leq 0.05$.

Heritability percentage in broad sense was very high between populations under study, ranged from 97.67 in plant height, 93.73 in number of tillers, 89.75 in forage yield and 89.89 in dry yield. However, high broad sense heritability is not always correlated with high narrow sense heritability.

I_1 generation plants reported differed performance from each population to another. Hatour and Narmer populations indicated no or little inbreeding depression for all traits but Hellaly population was low ID (-2.85% in plant height,-6.67% in no. of tillers, -5.26% in forage yield and -6.43% in Dry yield) follow by Serw-1 population (-7,64%in plant height, -14,29% in no.of tillers, -4,88% in forage yield and -5,45% in dry yield.

Gemmiza-1 population indicated more ID in plant height, forage and dry yield (-20%). Sakha-4 depressed -37.04% in number of tillers but ranged from -13.8 in forage yield and -17 in plant height (Table 3 and figure 1).

Table 3. Means of the first inbreeding generation (I_1) of plant height, number of tillers, forage and dry yield of different populations of berseem over two seasons (2006/07).

Population	Plant height cm	No. tillers	Fresh yield t.fed^{-1}	Dry yield kg fed^{-1}
Gemmiza-1	62.00 ^{e}	20.50 ^{c}	36.25 ^{d}	580.00 ^{d}
Giza-6	72.00 ^{c}	23.75 ^{c}	45.75 ^{c}	732.00 ^{c}
Hatour	85.00 ^{a}	34.50 ^{a}	67.25 ^{a}	1072.00 ^{a}
Hellaly	78.00 ^{b}	28.50 ^{b}	53.75 ^{b}	860.00 ^{b}
Narmer	80.25 ^{a}	31.25 ^{a}	62.50 ^{a}	972.00 ^{a}
Sakha-4	65.25 ^{d}	16.75 ^{d}	45.75 ^{c}	732.00 ^{c}
Serw-1	62.00 ^{e}	20.00 ^{c}	39.00 ^{d}	624.00 ^{d}
Mean	72.00	24.71	50..00	796.00
Heritability%	88.81	96.00	96.73	96.73

Values within a column for each principal factor not followed by the same letter are significantly different at $p \leq 0.05$.

Gemmiza-1, Giza-6 and Sakha-4 populations were more affected by the first inbreeding generation (figure 1). (Rammah 1969, Mahdy and Bakheit 1985, Rotilli and Gnocchi, 1989, El- Shahawy and Geit, 2001, Iannucci 2004 and Abdalla *et al* 2009) reported inbreeding depression in vigor and fertility accompanying inbreeding.

Highly significant differences were observed among and within populations for seed setting% in all modes of pollination (data not presented). Open pollination seed setting% ranged from 9.7% to 90.3% with mean 67.03 for all populations. The first inbred generation varied from the five control populations and the two developed ones (Hatour and Narmer). The developed populations were superior in setting seeds (49.25 and 53.5%, respectively), The other populations had lower percentage of seed setting ranged from 21.5 to 26.5% (Table 4). Developed populations

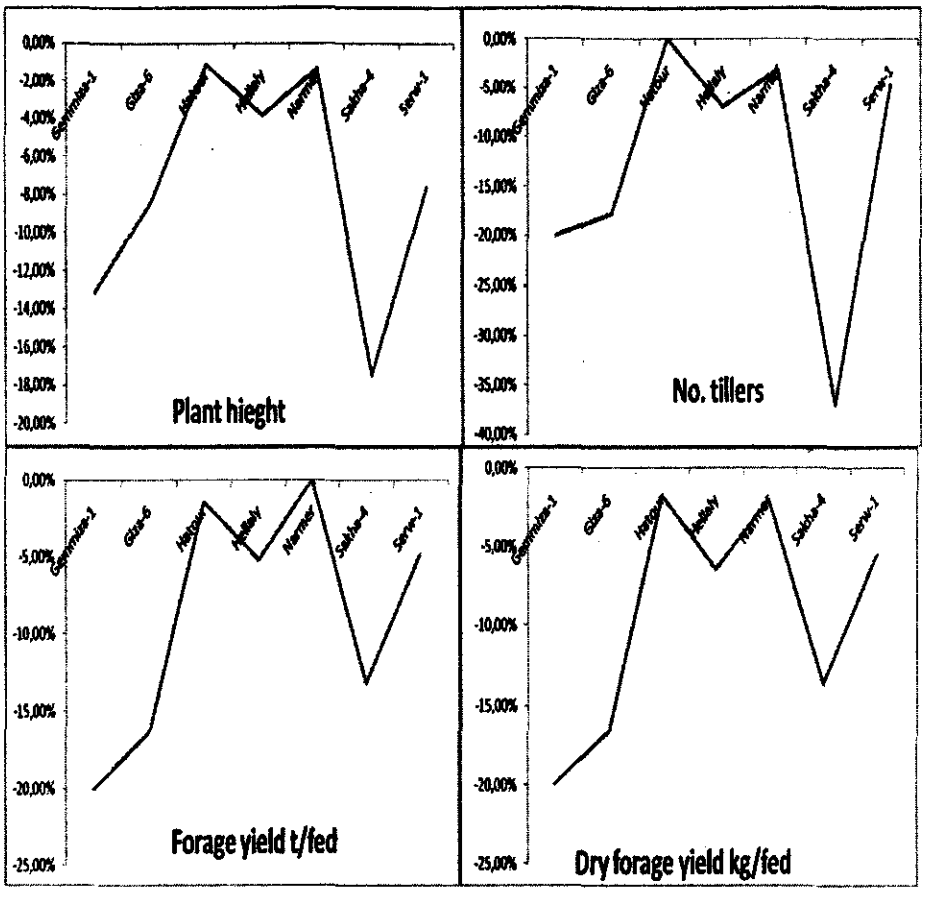

Fig. 1. Inbreeding depression (ID) % for plant height, No. of tillers, forage and dry yield of seven berseem populations

showed no sterile plants, but control populations recorded sterile (manual tripping, MT) plants ranged from 28% for Giza-6 to 32% for Hellaly and Sakha-4 and 34% for Serw-1 berseem populations (Table 4).

The second inbred generation (I_2) indicated similar performance of I_1 generation for seed setting of both new populations. Sterility percentage was decreased in I_2 compared to I_1 generation (Table 4). Seed setting ST system was very low compared to MT and OP pollinations. This indicates the need of tripping berseem flowers to improve seed setting.

Abdalla *et al* (2009), concluded that the better performance of selections over their original parents was due mainly to the great improvement in number of tillers per plant (in some cases increase of tillers was more than 100%) and to a less degree to an increase in plant height.

Table 4. Combined seed setting % of open pollination, I_1 and I_2 manual tripping and spontaneous tripping of different populations of berseem over two seasons (2005-06/2006/07).

Population	OP	I_1	I_2	ST	Sterility %	
					I_1	I_2
Gemmiza-1	57.25 [d]	26.50 [b]	23.12 [b]	4.00 [b]	32	17
Giza-6	65.25 [b]	22.75 [b]	21.81 [b]	4.50 [b]	28	9
Hatour	80.00 [a]	49.25 [a]	59.75 [a]	10.03 [a]	-	-
Hellaly	61.21 [bc]	21.50 [b]	22.87 [b]	4.50 [b]	30	14
Narmer	81.50 [a]	53.50 [a]	57.25 [a]	9.24 [a]	-	-
Sakha-4	63.50 [bc]	24.00 [b]	21.56 [b]	4.75 [b]	30	14
Serw-1	60.50 [c]	23.7 [b] 5	22.72 [b]	4.75 [b]	34	12
Mean	67.03	31.61	32.73	5.97		
Heritability%	95.06	94.49	96.29	89.06		

Values within a column for each principal factor not followed by the same letter are significantly different at $p \leq 0.05$.

Table 5. Correlation between dry yield and OP, I_1 and I_2 seed setting%

	Dry Yield	OP	I_1
OP	0.834**		
I_1	0.705 [ns]	0.942**	
I_2	0.773*	0.955**	0.986**

ns, *, **: not significant and significant at $p \leq 0.05$ and $p \leq 0.01$, respectively.
Number of plants = 100 plant.

The increase in number of tillers per plant will certainly be accompanied by an increase in number of leaves per plant and increase in number of inflorescences per plant. This will result in an improvement of vegetative growth, flowering and seed yield of selected genotypes.

Highly positive correlation was recorded between OP seed setting % and I_1 and I_2 inbred generations in all populations (Table 4). This may help the breeder to determine the system of pollination and trend of selection and improvement of the local berseem clover populations.

Miskawi berseem crowns were divided into two types (Figure 2). The first centered on one point and seems to have more size and weight and the second one has two or three (rarely four) pointed crown. All developed populations contains the two types of crown but the percentage of each other differed from population to another. This percentage may be considered as a feature to classify berseem populations.

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محصول العلف وعقد البذور لسبعة عشائر من البرسيم المصري

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أجريت هذه الدراسة في محطة البحوث الزراعية في الجيزة خلال مواسمي ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ وذلك باستخدام العشائر الأبوية وثلاثة من الأجيال الذاتية (I_0، I_1، I_2) بهدف دراسة

تأثير على الصفات الزراعية نتيجة التربية الذاتية Inbreeding في برنامج تربية البرسيم المصري. حيث تم تقييم سبعة عشائر من البرسيم المصري منها خمسة عشائر بلدية من مواقع جغرافية مختلفة هي (جيزة-٦ ، سخا-٤ ، هلالي ، جميزة-١، سرو-١) و عشيرتين محسنتين (هاتور ونارمر).

زرعت العشائر في تصميم قطاعات كاملة العشوائية في أربعة مكررات. وتمت المقارنة مي خلال ثلاث حشات. كما تم تقدير الخصوبة لعدد ٥٠ من النباتات الفردية في مكررين لدراسة عقد البذور بعد تغطية النورات الصغيرة بالأكياس وإطلاقها بلطف باليد بواسطة الأصابع (MT) ، وتم تغطية نورات أخرى وتركت لإنتاج بذور ذاتية (ST) بدون الفرك، وأيضا تركت نورات للتلقيح المفتوح (OP).

اظهر تحليل التباين التجميعي تأثيرا عالي المعنوية لعدد الفروع. كما اظهر التفاعل بين الأصناف تأثيرا معنويا بالنسبة للمحصول الأخضر والجاف و لم تكن هناك فروق معنوية بالنسبة لارتفاع النبات وعدد الفروع.

أظهرت العشيرتين المحسنين (هاتور ونارمر) تفوقا على جميع العشائر المحلية في جميع الصفات. كما اظهر معامل التوريث في المعنى الواسع للعشائر تحت الدراسة نسبة عالية تراوحت ما بين % ٩٧,٦٧ في ارتفاع النبات ، % ٩٣,٧٣ في عدد الفروع ، % ٨٩,٥٧ في محصول العلف الخضر و٨٩,٨٩% في المحصول الجاف. و قد كان هناك فروق عالية المعنوية بالنسبة لنسبة عقد البذور في جميع أنماط التلقيح.

أظهرت العشيرتين المحسنين (هاتور ونارمر) تفوقا الجيل الذاتي الأول و كذلك الجيل الذاتي الثاني حيث لم تظهر به أي نباتات عقيمة تحت نمط التلقيح اليدوي (MT) حيث ارتفعت نسبة العقد بالنسبة للتلقيح اليدوي في نباتات I_2 وهذه الصفة ارتبطت مع المحصول الخضر والجاف. كان هناك تلازم عالي المعنوية بين عقد البذور للنورات مفتوحة التلقيح ونورات التربية الداخلية للجيلين الأول والثاني (I_1 and I_2) وكذلك بين محصول العلف الجاف ونسبة عقد البذور علي النورات مفتوحة التلقيح (٠,٨٤%) في جميع الأصناف. لذلك ربما ينبغي للمربي الحرص علي انتخاب نباتات مرتفعة في نسبة الخصوبة و عقد البذور ثم تقييمها لإنتاجية محصول العلف الأخضر والجاف و عدد الفروع القاعدية الأكثر.

أظهر صنفي هاتور ونارمر عدم وجود تدهور في نباتات الجيل الذاتي الأول (I_1) بينما أظهرت الأصناف جميزة-١ و جيزة-٦ وسخا-٤ تدهور ملحوظ مع الجيل الأول من التربية الداخلية.

وقد أظهرت دراسة التفريع القاعدي أن عشائر البرسيم المصري تتميز منطقة التاج بها بنظامي تفريع: الأول تفريع مركزي حيث تخرج جميع الفروع من منطقة واحدة، والثاني تفريع متعدد حيث تكون هناك عدة نقاط تفريع عادة تتراوح من (٢-٣) وفي النادر قد تصل الي ٤. وتتميز جميع عشائر

البرسيم المصري بوجود كلا النمطين ولكن أحدهما يتميز بنسبة وجود أكبر. وتتباين نسب هذين النظائرين من عشيرة لأخري مما قد يجعل هذه النسب كصفة تقسيمية لتحديد مميزات كل صنف علي حدة.