

## Variability in Seed Yield of Multi-Cut Barseem Clover (*Trifolium alexandrinum*, L.) Gene Pool

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### ABSTRACT

The objective of the recent study was to detect variability in Egyptian multi-cut barseem gene pool *via* studying four different commercial populations regarding seed yield and seed yield components. These were; Khadarwi, Meskawi, Serow and Helaly. Means of total seed weight.plant<sup>-1</sup> were approximately similar for Khadarawi (26.131g) and Meskawi (26.122) population. This was affected by similar figures for seed yield components. Serow population scored the least seed weight.plant<sup>-1</sup> (21.981g) affected largely by the least number of seed.head<sup>-1</sup> (37.79 seed.head<sup>-1</sup>). Meanwhile, Helaly population had the second least total seed weight.plant<sup>-1</sup> (23.49g) affected also by low figure of number of seed.head<sup>-1</sup>. Major proportion of total variance ( $\sigma^2_p$ ) was contributed by the genotypic component ( $\sigma^2_g$ ) in total seed weight. plant<sup>-1</sup> and number of heads.plant<sup>-1</sup> in all studied barseem populations. Whereas, the genotypic variance represented a very limited portion of phenotypic variance for other studied seed yield components in all studied populations. Heritability estimates in khadarawi and Meskawi populations postulated a strong genetic control on total seed weight .plant<sup>-1</sup> and number of heads. plant<sup>-1</sup> (0.98 and 0.97%). While, weak estimates were recorded for number of seeds.head<sup>-1</sup>, seed weight.head<sup>-1</sup> and 1000 seed weight (0.23, 0.13 and 0.04%, respectively). Estimates of expected gain from selection the top 10% of half-sib families of khadarawi population might result in 59.85% increase in total seed weight, which amount to 15.64 g.plant<sup>-1</sup>. Concerning Helaly population selecting the top 10% of half-sib families might result in total seed weight.plant<sup>-1</sup> and number heads.plant<sup>-1</sup> increase of 72.43 and 67.09% which might amount to 17.01g.plant<sup>-1</sup> and 105.8heads.plant<sup>-1</sup>.

**keywords:** barseem clover, half-sib families, seed yield, PCV, GCV, heritability, genetic gain.

### INTRODUCTION

Barseem clover "*Trifolium alexandrinum*,L." is the second principle winter crop in Egypt. The area devoted for barseem cultivation approach 3 million Faddans. Produced barseem forage is consumed as soiling during winter and spring or hay and silage during summer and fall.

Seed yield is a second product of barseem cultivations. The monetary value of produced seed yield per unit area is approaching similar value to seasonal forage yield. In the meantime, the yield of seed is an exportable commodity to mediterranean basin countries that share with Egypt, barseem's cultivation.

Breeding for improved seed yield of barseem clover gained special interest in the last years. The success of programs depends upon the existing variability and the nature of genetic control on seed yield and yield component characters. Little available review regarding variability in seed yield and seed yield components of barseem clover illustrates the need for further studies. Variability in multi-cut type of barseem clover has been studied for forage yield and plant characters (Radwan and Abou-El-Fittoh 1970; Ali, 1971; El-Nahrawy, 1980; Bakheit, 1985; Mahdy, 1988; Rady, 2008; Badwy, 2013; Abd El-Naby *et al*, 2014 and Ahmed *et al*, 2015). Large genetic variability has been found

for seed yield and seed yield components. Recorded estimates for seed yield heritability reached 0.63 (Bakheit, 1989), 0.97 (Ahmed, 1992), 0.52 (Martiniello and Lannucci, 1998) and 0.595 (Rajab, 2010). Farid *et al* (1972) found that seed setting percentage was responsible for most of seed yield variations rather than 1000 seed weight .Phenotypic variation in seed yield amounted to 27% of obtained mean yield (Ahmed, 1992), 19.0% (Martiniello and Lannucci, 1998), 27.3% (Ahmed, 2000) and 12.7% (Rady, 2008).

The objective of the recent study was to detect variability in Egyptian multi-cut barseem gene pool *via* studying four different commercial populations regarding seed yield and seed yield components.

### MATERIALS AND METHODS

The recent study was carried-out at the experimental farm of Alexandria University located in Abbis 10km south of Alexandria city. Multi-cut gene pool of barseem was represented by four distinguished populations. These were; Khadarwi, Meskawi, Serow and Helaly. All four populations were registered and released by the Forage Crops Research Department (FCRD), Field Crop Research Institute (FCRI), Agricultural Research Center (A.R.C), Egypt.

In (2014-2015) winter season, seeds of the four populations were sown at the rate of 31.4 kg.ha<sup>-1</sup> in

hand drilled rows 4.0 m long and 20 cm apart (2.5g per plot). Populations were timely isolated by allowing a successive flowering started with Meskawi population, then Serow, then Helaly and finally Khadarawi populations. Serow Population flowered after three cutting since sown in mid-November. Whereas, Meskawi that sown in early October flowered after four cuttings. Helaly population that was sown in early November produced four cuttings and flowered before the last (Table 1).

At flowering, 300 plants with overall visual characters in each population were selected. Seeds from each plant were harvested separately to represent a half-sib family. One hundred half-sib families from each population with adequate seed were saved.

In (2015-2016) winter season, half-sib families of each population were evaluated in a separate experiment. Families of each population were divided to five sets each of twenty families. Each set was evaluated in a randomized complete block experiment with three replicates. Each plot represented by a single row 1.5 long and 0.2 on apart. Seeding rate was 31.4 kg.ha<sup>-1</sup> (1.03g.plot<sup>-1</sup>). Families rows were successively alternating. Sowing dates, cutting table and probable flowering dates were similar to what mentioned during the first year of the study (Table 1). Ten random plants from each plot were used to measure number of head.plant<sup>-1</sup>, number of seeds.head<sup>-1</sup>, seed weight.head<sup>-1</sup>, 1000 seed weight and total seed weight.plant<sup>-1</sup>.

Data were statistically analyzed for each population as outlined by Steel and Torrie (1980). Estimates of genetic ( $\sigma^2_g$ ), phenotypic ( $\sigma^2_p$ ), environmental ( $\sigma^2_e$ ) variances and heritability on means of plant basis as  $h^2 = [\sigma^2_g/\sigma^2_p]$  was calculated as given by Hallauer and Miranda (1981). Phenotypic (P.C.V.) and genotypic (G.C.V.) coefficients of variability were calculated according to Burton and De Vance (1953).

## RESULTS AND DISCUSSION

Analysis of variance indicated significant differences in total seed weight.plant<sup>-1</sup> and other seed yield component characters (i.e; number of head.plant<sup>-1</sup>, number of seeds.head<sup>-1</sup>, seed weight.head<sup>-1</sup> and 1000 seed weight) among half-sib families of Khadarawi and Helaly population. In both Meskawi and Serow population, the differences among the studied half-sib families in

1000 seed weight had not reached the level of significance (Table 2). Means of total seed weight.plant<sup>-1</sup> were approximately similar for Khadarawi (26.131g) and Meskawi (26.122) population. This was affected by similar figures for seed yield components. Serow population scored the least seed weight.plant<sup>-1</sup> (21.981g) affected largely by the least number of seed.head<sup>-1</sup> (37.79 seed.plant<sup>-1</sup>). Meanwhile, Helaly population had the second least total seed weight.plant<sup>-1</sup> (23.49g) affected also by low value of number of seed.head<sup>-1</sup>. The magnitude of ranges for total seed weight.plant<sup>-1</sup> among populations were very wide reached maximum value in Helaly population (51.61- 4.87= 46.74 g) followed by the corresponding value in Serow population (51.80-7.33= 43.47 g). The narrowest range in total seed weight.plant<sup>-1</sup> was recorded in Khadarawi population (53.86-9.10=44.76 g) followed by Meskawi population (49.65-9.25=40.40 g). the widest range in number of heads.plant<sup>-1</sup> were recorded for Khadarawi and Helaly population (512-10 and 417-62, respectively). Whereas, Meskawi and Serow populations exhibited very narrow range in this character (55-43 and 58-49, respectively).

Number of seeds.head<sup>-1</sup> ranged similarly among half-sib families of the four populations (96-15, 90-15, 81-15 and 89-15 seeds.head<sup>-1</sup> for Khadarawi, Meskawi, Serow and Helaly populations, respectively). The same was true for seed weight.head<sup>-1</sup> and 1000 seed weight. Commonly, it seems that the most differentiating seed yield characters among half-sib families of populations representing the multi-cut barseem gene pool might be number of heads.plant<sup>-1</sup> and seed weight.plant<sup>-1</sup>.

Phenotypic and genotypic variances, phenotypic and genotypic coefficients of variability, heritability, genetic advance from selection as units and genetic advance as percentage of the character mean are presented in (Table 3). Major proportion of total variance ( $\sigma^2_p$ ) was contributed by the genotypic component ( $\sigma^2_g$ ) in total seed weight.plant<sup>-1</sup> and number of heads.plant<sup>-1</sup> in all studied barseem populations. Whereas, the genotypic variance represented a very limited portion of phenotypic variance for other studied seed yield components in all studied populations.

**Table1: Sowing dates, Cutting table and Flowering dates of barseem populations.**

Population	Sowing date	Cuttings						flowering date
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	
Meskawi	1 <sup>st</sup> Oct.	1/12	11/1	11/2	11/3			1/4
Serow	15 <sup>th</sup> Nov.	15/1	25/2	25/3				20/4
Helaly	1 <sup>st</sup> Nov.	10/1	20/2	20/3	20/4			20/5
Khadarawi	15 <sup>th</sup> Oct.	15/12	25/1	25/2	25/3	25/4	25/5	15/6

**Table 2: Mean squares from ANOVA, ranges and means of half-sibs Seed yield characters of 100 half-sib families from each of Khadarawi, Meskawi, Serow and Helaly populations of barseem clover.**

Character	Range	Mean	Mean square	
			Half-sib	Error
<b>Khadarawi</b>				
Number of heads.plant <sup>-1</sup>	(10-512)	170.054	18918.48**	122.082
Number of seeds.head <sup>-1</sup>	(15-96)	46.301	1393.38*	1151.386
Seed weight.head <sup>-1</sup>	(0.05-0.35)	0.168	0.006*	0.002
1000 seed weight	(3.3-3.7)	3.408	0.009*	0.007
Total seed weight.plant <sup>-1</sup>	(9.1-53.86)	26.131	359.810**	1.816
<b>Meskawi</b>				
Number of heads.plant <sup>-1</sup>	(55-43)	164.288	15196.078**	97.546
Number of seeds.head <sup>-1</sup>	(15-90)	46.650	317.758**	148.504
Seed weight.head <sup>-1</sup>	(0.06-0.29)	0.178	0.005**	0.002
1000 seed weight	(3.3-3.9)	3.462	0.022 <sup>n.s</sup>	0.026
Total seed weight.plant <sup>-1</sup>	(9.25-49.65)	26.122	315.459**	1.327
<b>Serow</b>				
Number of heads.plant <sup>-1</sup>	(58-49)	165.47	21881.436**	311.940
Number of seeds.head <sup>-1</sup>	(15-81)	37.788	204.148*	136.443
Seed weight.head <sup>-1</sup>	(0.06-0.28)	0.144	0.003*	0.002
1000 seed weight	(3.3-3.9)	3.435	0.012 <sup>n.s</sup>	0.015
Total seed weight.plant <sup>-1</sup>	(7.33-51.8)	21.981	330.587**	28.248
<b>Helaly</b>				
Number of heads.plant <sup>-1</sup>	(62-417)	157.723	16471.823**	100.537
Number of seeds.head <sup>-1</sup>	(15-89)	41.593	444.604**	169.748
Seed weight.head <sup>-1</sup>	(0.05-0.34)	0.159	0.007**	0.002
1000 seed weight	(3.3-3.9)	3.450	0.021*	0.019
Total seed weight.plant <sup>-1</sup>	(4.87-51.61)	23.486	432.906**	2.767

**Table 3: Phenotypic variance ( $\sigma^2_p$ ), genotypic variance ( $\sigma^2_g$ ), phenotypic coefficient of Variation (P.C.V.), genotypic coefficient of variation (G.C.V.), heritability ( $h^2$ ), genetic advance (G.A) and genetic advance as % of a mean (G.A%) for seed yield characters of Khadarawi, Meskawi, Serow and Helaly populations of barseem clover.**

Characters	Estimate								
	$\sigma^2_p$	$\sigma^2_g$	P.C.V	G.C.V	$h^2$	G.A			
						10%	20%	10%	20%
<b>Khadarawi</b>									
Number of heads.plant <sup>-1</sup>	4821.1	4699.1	40.83	40.31	0.97	112.5	94.29	66.14	55.45
Number of seeds.head <sup>-1</sup>	1211.8	60.49	75.19	16.79	0.05	2.85	2.39	6.16	5.16
Seed weight.head <sup>-1</sup>	0.003	0.001	32.61	18.82	0.67	0.087	0.073	51.79	43.45
1000 seed weight	0.007	0.0005	2.54	2.07	0.07	0.009	0.008	0.26	0.23
Total seed weight.plant <sup>-1</sup>	91.31	89.49	36.57	36.20	0.98	15.64	13.11	59.85	50.17
<b>Meskawi</b>									
Number of heads.plant <sup>-1</sup>	3872.1	3774.6	0.38	0.38	0.97	100.8	84.50	61.36	51.43
Number of seeds.head <sup>-1</sup>	190.81	42.314	0.29	0.14	0.23	5.31	4.45	11.38	9.54
Seed weight.head <sup>-1</sup>	0.0058	0.0007	0.43	0.15	0.13	0.017	0.014	9.55	7.87
1000 seed weight	0.025	0.01	0.05	0.009	0.04	0.011	0.008	0.32	0.25
Total seed weight.plant <sup>-1</sup>	79.86	78.533	0.34	0.34	0.98	14.63	12.26	56.01	46.93
<b>Serow</b>									
Number of heads.plant <sup>-1</sup>	5704.3	5392.4	0.46	0.44	0.95	119.8	100.45	75.41	60.71
Number of seeds.head <sup>-1</sup>	153.4	16.93	0.33	0.11	0.11	2.27	1.91	6.01	5.05
Seed weight.head <sup>-1</sup>	0.005	0.0003	0.47	0.11	0.06	0.007	0.006	4.86	4.14
1000 seed weight	0.014	0.0008	0.034	0.008	0.05	0.009	0.0084	0.29	0.24
Total seed weight.plant <sup>-1</sup>	103.8	75.59	0.46	0.39	0.73	12.42	10.41	56.50	47.36
<b>Helaly</b>									
Number of heads.plant <sup>-1</sup>	4179.9	4079.3	0.41	0.40	0.98	105.8	88.70	67.09	56.24
Number of seeds.head <sup>-1</sup>	238.5	68.71	0.37	0.19	0.29	7.48	6.27	17.98	15.07
Seed weight.head <sup>-1</sup>	0.005	0.003	0.028	0.31	0.56	0.06	0.05	37.7	31.45
1000 seed weight	0.019	0.0005	0.040	0.006	0.026	0.006	0.005	0.17	0.14
Total seed weight.plant <sup>-1</sup>	110.3	107.5	0.45	0.44	0.97	17.01	14.26	72.43	60.72

Phenotypic and genotypic coefficient of variability in khadarawi population reached 40% of over all mean of half-sib families in number of heads.plant<sup>-1</sup>, 36% in total seed weight.plant<sup>-1</sup>. Whereas, genotypic coefficient of variability for number of seed.head<sup>-1</sup> represented 16.79% of families mean regarded by 75.19% phenotypic coefficient of variation. Variation at genotypic level in 1000 seed weight reached 2.07% of families mean regarded by 2.54% at phenotypic level. In other populations, variability at phenotypic or genotypic levels in all seed yield characters, showed negligible value as percentage of each population's families mean. Farid *et al* (1972) detected large figures for coefficient of variability for seed yield. He added that, seed setting percentage was responsible for most of seed yield variations rather than 1000 seed weight. Ahmed (1992) reached that, phenotypic differences among barseem entries in seed yield amounted to 30.31 and 27% of obtained mean yield of the first, second seasons and combined yield. Ahmed (2000) revealed that, phenotypic coefficient of variation for seed yield was 27.32%. EL-Nahrawy (2007), reached that P.C.V. for seed yield over seasons was high. Rady (2008) showed a (P.C.V.) for seed yield as 12.7%. Rajab (2010) recorded the highest (P.C.V.) values for seed yield followed by number of seeds.inflorescence<sup>-1</sup>. Rady (2008), reached the lowest significant values of seeds per inflorescence with Saidi and Meskawi populations, which were insignificantly different (37.13 and 41.6 seeds.head<sup>-1</sup>, respectively). While, Khadarwi I population exhibited the highest number of seeds.head<sup>-1</sup> (52.33 seeds.head<sup>-1</sup>). Variations in seeds setting as (P.C.V) reached 13 to 86% while (G.C.V) reached 7%.

Heritability estimates in khadarawi population postulated a strong genetic control on total seed weight .plant<sup>-1</sup> and number of heads.plant<sup>-1</sup> (0.98 and 0.97%). Also, seed weight.head<sup>-1</sup> gave a strong estimate of heritability (0.67%). In the meantime, genetic control on number of seeds.head<sup>-1</sup> and 1000 seed weight is relatively weak (0.05 and 0.07%). In Meskawi population, strong estimates of heritability were recorded for total seed weight.plant<sup>-1</sup> and number of heads.plant<sup>-1</sup> (0.98 and 0.97%). While, weak estimates were recorded for number of seeds.head<sup>-1</sup> seed weight.head<sup>-1</sup> and 1000 seed weight (0.23, 0.13 and 0.04%, respectively). As for Serow population, strong estimates of heritability were recorded for number of heads.plant<sup>-1</sup> and total seed weight.plant<sup>-1</sup> (0.95 and 0.73%, respectively). Helaly population, had a strong estimates of heritability for number of heads.plant<sup>-1</sup>, total seed weight. plant<sup>-1</sup> and seed weight.head<sup>-1</sup> (0.98, 97 and 0.56%, respectively). On the other hand, estimates for other seed yield component were relatively weak. Malengier and Baer (2007) estimated heritability of seed yield in

red clover. Estimates were high amounted to 0.82 in the first season. Bakheit (1989) estimated broad-sense heritability for seed yield of barseem clover from variance components as 63.03%. Ahmed (1992) reached an estimate of 0.97 for seed yield of barseem. Rajab (2010) estimated heritability in broad-sense for seed yield as 0.96%.

Estimates of expected gain from selection the top 10% of half-sib families of khadarawi population might result in 59.85% increase in total seed weight, which amount to 15.64 g.plant<sup>-1</sup>. Also, it might result in 66.14% increase in number of heads.plant<sup>-1</sup> which amount to 94.29 head.plant<sup>-1</sup>. In addition, an increase in seed weight.head<sup>-1</sup> might reach 51.79% which amount to 0.087 g. head<sup>-1</sup>. Regarding Meskawi population selecting the top 10% of studied half-sib families might result in an increases of 56.61 and 61.36% in total seed weight.plant<sup>-1</sup> and number of heads.plant<sup>-1</sup>, which might amount to 14.63 g.plant<sup>-1</sup> and 100.8 head.plant<sup>-1</sup>. Improvements in other studied seed yield components were negligible. As for Serow population, the highest figures of response to selecting the top 10% half-sib families were recorded for number of heads.plant<sup>-1</sup> and total seed weight.plant<sup>-1</sup> (72.41 and 56.50%) which amount to 119.8 heads.plant<sup>-1</sup> and 12.42 g.plant<sup>-1</sup>. Concerning Helaly, strong improvement associated with selecting the top 10% of half-sib families were detected with total seed weight.plant<sup>-1</sup> and number heads.plant<sup>-1</sup> (72.43 and 67.09%) which might amount to 17.01 g.plant<sup>-1</sup> and 105.8 heads.plant<sup>-1</sup>. A moderate genetic advance was recorded for seed weight.head<sup>-1</sup> (37.74% which amount to 0.05 g.head<sup>-1</sup>).

Genetic gain from selecting the top 20% of half-sib families in all studied populations was parallel to what noticed with 10% selection intensity with the advantage of keeping larger variability that enable successive cycles of selection. Abou- EL-Shawareb (1971) obtained a gain from selection reached 19.9 to 29.0% in seed yield of Meskawi barseem clover. Bakheit (1989) recorded a realized gain in seed yield from selection amounted to 17.47%. Ahmed (2000), obtained a realized gain in seed yield of barseem of 8.55% from index selection. Ahmed (2006) obtained a gain from selection in seed yield lowest when half-sib families were evaluated. Bakheit *et al.* (2007) recorded a realized gain in seed yield of barseem ranged between 13.59 and 18.45%.

Commonly, the genetic coefficient of variability is a measure of relative genetic variation. Breeders can't rely on such measure alone, because it is a function of both genetic variation and population mean. The expected genetic advance is more appropriate to compare the gain from selection than heritability as the former combines heritability, phenotypic variation and

selection differential. High genetic advance values for seed weight. plant<sup>-1</sup> and number of heads. plant<sup>-1</sup> indicated that these characters were governed largely through the additive affect of genes and the improvement in these characters might be achieved through phenotypic selection (Johnson *et al*, 1955).

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## تصنيفات محصول البذرة في الوعاء الجيني للبرسيم المصري متعدد الحشوات "*Trifolium alexandrinum*, L."

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### الملخص العربي

الهدف من الدراسة الحالية هو تقدير الاختلافات في الوعاء الجيني للبرسيم المصري من خلال دراسة اربعة عشائر تجارية من حيث محصول البذرة ومكوناته. العشائر المدروسة هي خضراوي ومسقاوي وسرو وهلاللي. متوسطات محصول البذرة الكلي/نبات كانت متماثلة تقريبا في كل من عشيرتي الخضراوي (٢٦,١٣١جم) والمسقاوي (٢٦,١٢٢جم). وقد تأثرت تلك القيم بتقديرات متماثلة لمكونات البذرة. وقد سجلت عشيرة السرو أقل قيم وزن بذور /نبات (٢٦,٩٨١ جم) متأثرة بدرجة كبيرة بقيم متدنية لكل من عدد البذور/ راس (٣٧,٧٩). وقد سجلت عشيرة الهلاللي ثاني اقل وزن بذور الكلي/نبات(٢٣,٤٩ جم) متأثرا بالقيم المتدنية لصفة عدد البذور/راس. جزء كبير من التباين الكلي ( $\sigma^2 p$ ) في الوزن الكلي للبذور /نبات وعدد النورات /نبات يرجع الي المكون الوراثي ( $\sigma^2 g$ ) في جميع عشائر البرسيم المدروسة. بينما كانت مشاركة التباين الوراثي محدودة في صفات مكونات محصول البذرة الاخرى المدروسة في جميع العشائر المدروسة. تقديرات معامل التوريث، اظهرت تحكم وراثي قوي في وزن البذور الكلي /نبات وعدد النورات/نبات (٠,٩٨ و ٠,٩٧%) في عشيرتي الخضراوي والمسقاوي. بينما سجلت تقديرات ضعيفة لعدد البذور/ راس ووزن البذور/ راس ووزن ١٠٠٠ بذرة (٠,٢٣ و ٠,١٣ و ٠,٤٠ علي الترتيب). تقديرات التحسن المتوقع من الانتخاب اعلي ١٠% من العائلات النصف شقيقة لعشيرة الخضراوي. قد تؤدي الي زيادة في وزن البذور الكلي / نبات تبلغ ٥٩,٨٥ % بينما يساوي ١٥,٦٤ جم /نبات. اما في عشيرة الهلاللي فان انتخاب اعلي ١٠% من العائلات النصف شقيقة يؤدي الي زيادة في صفات الوزن الكلي للبذور/نبات وعدد النورات /نبات تبلغ ٧٢,٤٣% و ٦٧,٠٩% والتي تصل الي ١٧,٠١ جم/نبات و ١٠٥,٨ راس/نبات.