VARIABILITY AND CHARACTERS ASSOICIATION IN SOME POPULATIONS OF ALFALFA

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ABSTRACT

Two experiments were carried out at the Experimental Farm, of Agricultural Research Center at Giza. In experiment I, 23 collections of alfalfa populations along with three checks (Sewa1, Ismailia 1 and Ismailia 94) were evaluated for forage yield and its components. In Experiment II, the best twelve populations selected from experiment I as well as the two check varieties (Sewa1 and Ismailia 94) were evaluated over two growing seasons and two years. Phenotypic (PCV%), genotypic (GCV%) coefficients of variability, heritability in broad sense and co-heritability were calculated for all studied traits. Results of experiment I indicated that alfalfa populations were differed significantly for all studied traits except plant height. Population # 17 exhibited the highest significant mean values for green and dry yields. The highest phenotypic and genotypic coefficients of variability were detected for green and dry yields. Broad sense heritability estimates were high for all studied traits. Positive and highly significant phenotypic and genotypic correlation estimates were detected between leaf dry weight and stem dry weight and between green yield weight and dry yield weight. Co-heritability estimates were positive and significant among all studied traits. Results of experiment II indicated that alfalfa populations exhibited significant differences for all traits. Population # 12 expressed the highest significant green yield weight while population # 2 expressed the highest dry yield weight. Plant height exhibited greater magnitude of genotypic and phenotypic coefficient of variability followed by green yield weight. Positive and significant phenotypic correlations were detected between leaf dry weight and stem dry weight and also between green yield weight and dry yield weight. Heritability values in broad sense ranged from moderate to high for studied traits. Genetic advance was high for most traits. Positive and significant co-heritability estimates were detected among all traits except between plant height and dry yield weight.

Key words: Coefficient of variation, heritability, co-heritability.

INTRODUCTION

Alfalfa (*Medicago sativa* L.,*)* is one of the most nutrition forage crops available for animal feed. Alfalfa is an important crop not only for its feeding value but also for its role in improving soil fertility. In addition to its high adaptability under different environmental condition. Alfalfa could offer permanent source of green fodder around the year. In Egypt, increasing alfalfa forage production is considered as one of the most important goals. The success of any breeding program depends on the amount of genetic variability available in the germplasm pool and information about the characters associated with forage yield .Therefore, collection, identification and evaluation of diverse local genotypes or introduced cultivars may help the plant breeders to constructs effective breeding program.

Many investigators revealed that alfalfa populations differed in its forage production as indicated by **Holland and Bingham (1994)**. For alfalfa populations, **Ahmed and Nabila Mohamed (1995**) studied 18 alfalfa varieties for yield and its components and they found significant effects among populations, cuts and cuts x populations. Moreover, **Mousa *et al* (1996**) found significant effects due plant height, number of tillers/ plant, leaf/ stem ratio and yield of six alfalfa populations during growing seasons and cuts. **Abdel–Halim *et al* (1998**) evaluated six cultivars of alfalfa included Giza1, Ismailia1 and WL605 for agricultural traits, they found that the two varieties had the most productivity in winter, spring and summer season than the autumn one. **Hamed (2004**) evaluated 14 populations in New Valley during different years and growing season and reported the main effects for populations, growing season , years and their interaction were significant for forage yield production and its components. **Hefny (2007) c**ame to similar conclusion when he evaluated 13 alfalfa populations during different growth seasons and cuts. Also, **Hoda *et al.* (2015**) evaluated five Egyptian alfalfa varieties and found significant differences among these varieties for forage yield and yield components. This investigation was conducted to evaluate 23 alfalfa ecotypes collected from the New Valley for yield and its components, and estimate genetic variability and association among some traits of alfalfa.

MATERIALS AND METHODS

Two experiments were carried out at the Experimental Farm, of Agricultural Research Center at Giza to evaluate 23 collection alfalfa populations for forage yield and its components in comparison with three check varieties (Sewa1, Ismailia 1 and Ismailia 94). The population was collected from farmer's field for alfalfa in the New Valley. In Experiment1, seeds were drilled on October 1st, 2003 by hand at the rate of 5 gram seeds per rows .The experimental plots consisted of four rows each of 4 meters long and 25 cm apart. The best twelve populations selected from experiment 1 as well as the two check varieties (Sewa1 and Ismailia 94) were evaluated for high yield and its components over two growing seasons and two years (Experiment II).

In October 1st 2004, about 20 selected seedling for each chosen populations which selected from the experiment 1 were transplanted in the field and were maintained to the second year (2005/2006). Each experimental plot consisted of two rows with length of 3 meters. The seedling was individual spaced 30 cm with and 30 cm between rows. The entries in both experiments 1 and experiments11 were evaluated in a Randomized Complete Block Design with three replicates. Five cuts were taken yearly (two in spring season and three in summer season) whereas, plants were left for seed production. The normal cultural practices adapted at the location were followed. The followed characteristics were recorded on ten plants at different cutting in both experiments**:** plant height (cm), number of tillers/ plant, Dry weight of stem (g /plot), Dry weight of leaves (g /plot), Fresh yield (kg / plot) and Dry yield (kg/plot).

Analysis of variance was carried according to **Steel and Torrie (1960)** and treatment means were compared statistically using the test of least significant

differences variance was carried out on the individual growing season in experiment1, but combined analysis of variance over growing seasons and years was computed in experiment 11. Phenotypic (PCV%) and genotypic (GCV%) coefficients of variability and heritability in broad sense for all traits were calculated according to **Johnson *et al.* (1955)** and **Kumar *et al.* (1985).** Co-heritability was calculated according to **Janssen (1979).**

RESULTS AND DISCUSSION

For simplicity, the results of this work could be presented and discussed under two parts (one for each experiment of study):

Part I. Experiment I:

The mean performance of plant height, leaf and stem weight, number of tillers/ plant, green and dry weight for all populations studied was presented in Table 1. Results indicated significant differences among different populations for all studied traits except plant height. It is clear that genotype #5 expressed the highest mean value for leaf dry weight and stem dry weight being 2.248 and 1.596 g, respectively. Population # 18 gave the highest mean value for number of tillers/ plant population # 17 exhibited the highest significant mean values for green and dry yield weight recording 31.410 and 8.957 kg/ plot, respectively. Such variability among alfalfa genotypes was previously reported by several investigators (**Hamed ,2004; Hefny, 2007 and Tucak, *et al.* 2008**).

Results in Table 2 revealed that phenotypic coefficient of variability (PCV) was higher than corresponding genotypic coefficient of variability (GCV) for all traits demonstrating the great effect of environment on such traits. The highest phenotypic and genotypic coefficient of variability were detected for green yield weight (15.14 and 14.75) and dry yield weight (3.27 and 3.18), respectively. Such results indicates the presence of exploitable genetic variability for these characters. Broad sense heritability estimates were high for all studied traits ranging from 99.12% for green yield weight to 97.97% for fry yield weight (Table 2). High estimates of broad sense heritability would be effective in improving these characters. Expected genetic advance was higher for green and dry yield weights. It is well known that high heritability estimate accompanied by high genetic value confirms the role of additive gene in controlling these traits. Therefore, a high genetic gain could be possible through selection program. Similar results were recorded by **Chaudhry *et al.*, 1993**, and **Hoda *et al*, 2015**.

Phenotypic and genotypic correlation values for all traits are presented in Tables 3 and 4. In general, phenotypic correlation values were lower than that of genotypic correlation values for all studied traits. However, positive and highly significant phenotypic correlation estimates were detected between leaf dry weight and stem dry weight **.**

Table (1): Mean values of green & dry forage alfalfa yield and its related characters for parent 26 population genotypes.

Genotypes	Plant height (cm)	Leaf dry weight (g)	Stem dry weight (g)	No. of tiller/ plant	Green yield weight	Dry yield weight
1	58.80	1.66	1.38	16.93	17.90	4.99
2	69.40	1.29	1.07	14.83	22.90	6.81
3	56.43	1.69	1.51	15.37	22.63	5.51
4	61.27	1.37	1.20	14.37	21.68	6.33
5	64.576	**2.248**	**1.60**	14.30	24.50	7.59
6	56.60	1.73	1.50	14.27	25.78	7.52
7	60.47	1.76	1.52	14.87	25.47	7.02
8	57.67	1.74	1.47	15.57	27.80	7.90
9	61.47	1.78	1.51	15.07	26.59	7.40
10	62.43	1.37	1.07	14.73	25.39	6.83
11	61.23	1.76	1.30	16.10	22.88	6.45
12	61.57	1.28	1.16	16.43	28.24	7.77
13	57.97	1.49	1.35	16.80	25.20	7.10
14	57.03	0.94	0.79	14.97	22.90	6.63
15	57.83	0.99	0.73	15.03	28.81	7.54
16	58.60	1.04	0.78	14.37	30.29	7.47
17	60.33	1.03	0.77	15.07	**31.41**	**8.96**
18	57.47	1.17	0.80	**17.43**	30.33	7.92
19	55.77	1.10	0.83	17.10	29.74	8.43
20	54.83	1.08	0.86	17.37	28.45	7.12
21	56.13	1.09	0.81	15.63	28.97	7.72
22	57.50	1.04	0.81	15.80	29.14	7.08
23	59.63	1.07	0.76	16.03	30.15	6.92
Sewa1	59.40	1.01	0.79	16.07	30.89	7.58
Ismailia1	**88.70**	1.03	0.75	16.80	29.16	7.56
Ismailia94	62.03	0.97	0.74	16.87	29.96	7.78
LSD 5%	N.S	0.11	0.11	0.29	0.92	0.33
LSD 1%	N.S	0.14	0.14	0.39	1.23	0.45

The under line and bold font indicate the highest mean values in each characters.

Table (2): Genetic parameters of green & dry forage alfalfa yield and its related characters for parent 26 population genotypes.

Characters	Genetic parameters					
	Genotypic variance	Phenotypic variance	GCV	PCV	Broad sense heritability (h^2)	Expected genetic advance% (mean)
Leaf dry weight	0.12	0.13	3.07	3.18	0.98	19.46
Stem dry weight	0.09	0.10	3.10	3.24	0.99	19.74
Branches No.	1.024	1.06	2.17	2.24	0.99	13.73
Green yield weight	11.86	12.18	14.75	15.14	0.99	92.90
Dry yield weight	0.67	0.71	3.18	3.278	0.98	19.87

Table (3): Phenotypic correlation coefficients among green & dry forage alfalfa yield and its related characters for parent 26 population genotypes.

Characters	Plant height	Leaf	Stem	Branches No.	Green yield weight	Dry yield weight
Leaf dry weight		**1.000**	**0.954****	**-0.317**	**-0.571****	**-0.307**
Stem dry weight			**1.000**	**-0.317**	**-0.627****	**-0.376**
Branches No.				**1.000**	**0.236**	**0.054**
Green yield weight					**1.000**	**0.810****
Dry yield weight						**1.000**

*** and **: Significant and highly significant at 0.05 and 0.01 probability levels, respectively.**

Table (4): Genotypic correlation coefficients among green & dry forage alfalfa yield and its related characters for parent 26 population genotypes.

Characters	Plant height	Leaf	Stem	Branches No.	Green yield weight	Dry yield weight
Leaf dry weight		**1.000**	**0.958****	**-0.327**	**-0.589****	**-0.323**
Stem dry weight			**1.000**	**-0.330**	**-0.646****	**-0.393***
Branches No.				**1.000**	**0.247**	**0.064**
Green yield weight					**1.000**	**0.831****
Dry yield weight						**1.000**

* and **: Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

(0.654**). Negative and highly significant phenotypic correlation values were detected between green yield weight and each of leaf dry weight (-0.571**) and stem dry weight (-0.627**). Also, positive and significant phenotypic correlation values were detected between green yield weight and dry yield weight being 0.810** (Table 3).

For genetic association similar trend was obtained where positive and significant genotypic correlation values were detected between leaf dry weight and stem dry weight (0.958**). Negative and significant association was observed between green yield weight and each of leaf dry weight (-0.589**) and stem dry weight (-0.646**). Meantime, positive and significant genotypic correlation values were obtained between green yield weight and dry yield weight recording 0.831** (Table 4). These results are in line with those obtained by **Hoda *et al* (2015)**.

Co-heritability refers to joint transmission of' different characters pairs is a better Genetic parameter for improving selection efficiency as it permits a study of simultaneous changes in different characters (Srivastava and Jain 1994). Co-heritability takes both genotypic as well as phenotypic covariance into account and helps In understanding changes taking place in pairs of polygenic characters. Co- heritability correlation coefficients for the studied traits are presented in Table 5. Results indicated that co-heritability estimates were positive and significant among all studied traits. Moreover, highest co-heritability estimates were found between number of tillers and each of dry yield weight (1.114) and green yield weight (1.016). This means that green and dry yield weight is more influenced by

number of tillers/ plant rather than other studied characters. Also, higher co-heritability estimates was higher between leaf dry weight and dry yield weight (1.004) and between stem dry weight and number of tillers/ plant (1.003). These results are in line with those obtained by **Shobha Rani and Sumalini (2013).**

Table (5): Co heritability correlation coefficients among green & dry forage alfalfa yield and its related characters for parent 26 population genotypes.

Characters	Plant height	Leaf dry weight	Stem dry weight	No. of tillers	Green yield weight	Dry yield weight
Leaf dry weight		1.000	0.967**	1.000**	1.000**	1.004**
Stem dry weight			1.000	1.003**	0.996**	0.994**
No. of tillers				1.000	1.016**	1.114**
Green yield weight					1.000	0.983**
Dry yield weight						1.000

*** and **: Significant and highly significant at 0.05 and 0.01 probability levels, espectively.**

Part II. Second experiment:

Mean values of green and dry forage alfalfa yield and its related characters for 14 populations are presented in Table 6. Results indicated that the studied genotypes exhibited significant differences for all studied traits. Moreover, population # 9 expressed the highest mean value for plant height (43.10 cm) without significant difference from the two checks (Sewa 1 and Ismailia 94). Genotype # 2 ranked the second best for plant height recording 4043 cm. For leaf dry weight, genotype # 11 expressed the highest significant mean values (2.51 g) as compared to the two checks. Population # ranked the second best for this traits followed by genotype # 5 (2.23 g). Concerning stem dry weight, population # 3 expressed the highest significant mean value being 16.43 g followed by population # 3 (1.40). For number of tillers/ plant, population # 3 gave the highest mean value being 16.43 followed by population # 4 (16.17). The highest significant mean value for green yield was obtained by population # 12 (26.49 kg) followed by population # 8 (25.11). Population # 2 gave the best mean value for dry yield being 5.06 kg followed by population # 8 (4.78 kg). Similar results were recorded by **Hefny (2007)** and **Tucak *et al*. (2008).**

The under line and bold font indicate the highest mean values in each characters.

Phenotypic and genotypic coefficient of variability, broad sense heritability and expected genetic advance for all studied traits are presented in Table 7. Results indicated that phenotypic coefficients of variability were higher than corresponding genotypic ones for all studied traits. Plant height exhibited greater magnitude of genotypic coefficient of variability (10.34) followed by green yield weight (7.08) and leaf area weight (2.93). The corresponding estimates of phenotypic coefficient of variability had the same trend where plant height had the highest value (22.81) followed by green yield weight (9.45) and leaf dry weight (2.94). Heritability values in broad sense were high for leaf dry weight, stem dry weight, number of tillers/ plant and green yield weight and moderate for plant height and dry yield weight. Genetic advance was high for plant height green yield weight and leaf dry weight. In this connection, **Portabelia *et al.* (1982)** reported that traits with high heritability values along with high genetic advance demonstrate the predominance

of gene action in the inheritance of these traits. Phenotypic correlation coefficients for all studied traits are presented in Table 8. Positive and significant phenotypic correlation values were detected between leaf dry weight and stem dry weight and also between green yield weight and dry yield weight.

Table (6): Mean values of green & dry forage alfalfa yield and its related characters for S1 (14 population) genotypes.

Genotypes	Plant height	Leaf dry weight	Stem dry weight	No. of tillers	Green yield weight	Dry yield weight
1	41.50	1.39	0.81	14.47	18.30	4.10
2	40.43	1.08	0.72	14.57	21.81	**5.06**
3	39.6	1.80	1.40	**16.43**	20.68	4.19
4	39.23	1.42	0.85	16.17	19.55	3.69
5	32.27	2.23	1.35	15.83	21.43	4.05
6	34.80	1.481	1.07	15.30	22.81	4.21
7	35.27	1.51	0.99	14.87	21.22	3.86
8	38.73	1.43	0.92	14.87	25.11	4.78
9	**43.10**	1.47	1.02	15.30	23.72	3.82
10	36.43	1.42	0.92	16.03	19.97	3.49
11	36.23	**2.51**	**1.48**	15.80	20.81	3.53
12	27.50	1.31	0.84	15.23	**26.49**	4.70
Sewa1	39.50	1.42	1.06	15.87	24.00	4.59
Ismailia94	37.93	1.62	0.69	16.07	20.61	4.67
LSD 5%	6.27	0.03	0.05	0.36	2.09	0.68
LSD 1%	8.48	0.04	0.07	0.48	2.83	0.92

Also, positive and significant genotypic correlations were obtained between leaf dry weight and stem dry weight (Table, 9). While, the genotypic association was negative and significant between leaf dry weight and dry yield weight. Similar results were obtained by **Hoda *et al.* (2015)**.

Table (7): Genetic parameters of green & dry forage alfalfa yield and its related characters for S1 (14 population) genotypes.

Characters	Genetic parameters					
	Genotypic variance	Phenotypic variance	GCV	PCV	Broad sense heritability (h^2)	Expected genetic advance% (mean)
Plant height	11.58	25.54	10.34	22.81	0.71	100.71
Leaf dry weight	0.14	0.14	2.93	2.94	0.99	18.18
Stem dry weight	0.06	0.06	1.98	2.01	0.99	12.40
No. of tillers	0.38	0.43	0.82	0.98	0.96	5.46
Green yield weight	4.65	6.21	7.08	9.45	0.89	52.60
Dry yield weight	0.19	0.36	1.53	2.82	0.78	13.62

Table (8): Phenotypic correlation coefficients among green & dry forage alfalfa yield and its related characters for S1 (14 population) genotypes.

Characters	Plant height	Leaf dry weight	Stem dry weight	No. of tillers	Green yield weight	Dry yield weight
Plant height	1.000	-0.187	-0.128	-0.029	-0.228	0.062
Leaf dry weight		1.000	0.827**	0.437	-0.209	-0.398
Stem dry weight			1.000	0.424	-0.038	-0.368
No. of tillers				1.000	-0.151	-0.274
Green yield weight					1.000	0.541*
Dry yield weight						1.000

* and **: Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Table (9): Genotypic correlation coefficients among green & dry forage alfalfa yield and its related characters for S1 (14 population) genotypes.

Characters	Plant height	Leaf dry weight	Stem dry weight	No. of tillers	Green yield weight	Dry yield weight
Plant height	1.000	-0.263	-0.163	-0.130	-0.503	-0.146
Leaf dry weight		1.000	0.834**	0.461	-0.240	-0.533*
Stem dry weight			1.000	0.442	-0.047	-0.529
No. of tillers				1.000	-0.234	-0.431
Green yield weight					1.000	0.500
Dry yield weight						1.000

* and **: Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Co-heritability correlation coefficients for all studied traits are presented in Table 10. Positive and significant co-heritability estimates were detected among all studied traits except between plant height and dry yield weight. However, between highest co-heritability estimates were exhibited between green yield weight and each of plant height (1.283**), stem dry weight (1.062**) and number of tillers/ plant (1.268**). Such results indicated that green yield weight is more influenced by plant height, stem dry weight and number of tillers/ plant. Similar results were obtained by **Shobha Rani and Sumalini (2013).**

Table (10): Co heritability correlation coefficients among green & dry forage alfalfa yield and its related characters for S1 (14 population) genotypes.

Characters	Plant height	Leaf dry weight	Stem dry weight	No. of tillers	Green yield weight	Dry yield weight
Plant height	1.000	0.946**	0.854**	2.874**	1.283**	-1.170**
Leaf dry weight		1.000	0.999**	0.996**	0.994**	0.984**
Stem dry weight			1.000	0.979**	1.062**	1.050**
No. of tillers				1.000	1.268**	1.093**
Green yield weight					1.000	0.588*
Dry yield weight						1.000

* and **: Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

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التباين الوراثى والعلاقات الإرتباطية بين بعض الصفات الهامة فى عشائر البرسيم الحجازى

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة وأشتملت التجربة الأولى على ٢٣ عشيرة من البرسيم الحجازى مع ثلاثة أصناف للمقارنة (سيوة ١، اسماعيلية ١، اسماعيلية ٩٤) لتقييم محصول العلف ومكوناته. وفى التجربة الثانية تم انتخاب ١٢ عشيرة من عشائر التجربة الأولى وتم زراعتها مع صنفين للمقارنة (سيوة ١، اسماعيلية ٩٤) وفى هذه التجربة الثانية تم تقييم جميع التراكيب الوراثية فى موسمين زراعيين وسنتين متتاليتن لتقييم محصول العلف ومكوناته فى البرسيم الحجازى.

استخدم تصميم القطاعات الكاملة العشوائية مع ثلاثة مكررات فى كلا التجربتين، وتم أجراء التحليل التجميعى للتجربة الثانية. تم تقدير معامل الاختلاف المظهرى والوراثى وكذلك الإرتباط الوراثى والمظهرى ودرجة التوريث والتحسين المتوقع من الانتخاب ودرجة التوريث المشتركة بين الصفات المدروسة. وأظهرت نتائج التجربة الأولى ان هناك فروق معنوية بين جميع عشائر البرسيم الحجازى التى تم دراستها لجميع الصفات ماعدا ارتفاع النبات.

وأعطت العشيرة رقم ١٧ أعلى محصول علف اخضر وجاف، كما كان معامل الاختلاف المظهرى والوراثى اعلى لصفتى محصول العلف الاخضر والجاف. وكانت قيم درجة التوريث عالية لجميع الصفات تحت الدراسة. وكان قيم معامل الارتباط المظهرى والوراثى موجبة وعالية المعنوية بين الوزن الجاف للأوراق والوزن الجاف للسيقان وكذلك بين محصول العلف الأخضر والمحصول الجاف. وكانت قياسات درجة التوريث المشتركة موجبة ومعنوية بين جميع الصفات تحت الدراسة. وأظهرت نتائج التجربة الثانية ان الفروق كانت معنوية بين عشائر البرسيم الحجازى لجميع الصفات، وأعطت العشيرة رقم ١٢ اعلى محصول علف اخضر بينما اعطت العشيرة رقم ٢ اعلى محصول جاف. واعطت صفة ارتفاع النبات اعلى قيم لمعامل الاختلاف الوراثى والمظهرى يليها صفة محصول العلف الأخضر. وكان هناك ارتباط مظهرى موجب ومعنوى بين الوزن الجاف للأوراق والسيقان وكذلك بين محصول العلف الاخضر والجاف. وتراوحت قيم درجة التوريث من متوسطة الى مرتفعة للصفات المدروسة. وكانت قيم التحسين الوراثى المتوقع من الإنتخاب عالية لمعظم الصفات تحت الدراسة. وكانت قياسات درجة التوريث المشتركة موجبة ومعنوية لجميع الصفات ماعدا بين ارتفاع النبات ووزن العلف الجاف.