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Effect of Varieties and Sowing Dates on Forage Yield and its Components in Alfalfa (*Medicago sativa* L.)

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Abstract

This investigation was carried out to study the effect of temperature resulting from different sowing dates, varieties and their interaction on forage yield and its components of alfalfa. A set of seven varieties (Aswan, Balady, Dakhla, Ismailia-1, Nitrogen fixed, Genan, and Siwa) were sown on three sowing dates (20th of October, November and December) in randomized complete block design with three replicates in experimental farm of South Valley University during 2014/2015 and 2015/2016 seasons. Three cuts were taken after 80, 125 and 165 days from sowing. The results showed that the sowing dates and varieties had a significant effects on plant height, number of branches/plant, leaf/stem ratio, fresh and protein forage yields over the two seasons. Aswan population gave the tallest plant height, and highest forage yields over all sowing dates. Moreover, the tallest plant heightm highest number of branches/plant and seasonal fresh, dry and protein forage yields were obtained from the plants sown on 20th December over the two seasons.

The sowing dates and varieties and their interactions were significant for plant height, number of branches/plant, and seasonal, fresh, dry and protein forage yields. Finally the stability analysis revealed that the average stability region involved Siwa, Balady, Dakhla and Nitrogen fixed populations for plant height and Genan and Ismailia populations for seasonal fresh forage yield. Moreover, all seven populations except Dakhla and Aswan populations were involved in stability region for seasonal protein forage yield.

Keywords: *Alfalfa, Medicago sativa L., Sowing date, Stability, Genotype x environment interaction, forage yield and its components.*

Introduction

Alfalfa or lucerne (*Medicago sativa* L.), which is called "The Queen of Forges" is one of the most important forage crops in terms of total area, economic value and energy efficiency. Because alfalfa can fix nitrogen and synthesize protein, it is very useful to farmers, who have grown alfalfa as protein-rich fodder for many animals and chickens. It is cultivated over a wide range of climatic and edaphic conditions ranging from the semi-arid regions to the humid areas. It has been an important agronomic feature in restoring soil structure by the roots which create holes in the soil for air and water. Moreover, alfalfa needs only low fertilizer inputs and herbicides or pesticides.

The production of alfalfa did not satisfy the local requirements of animal feeding which are suffering from serious feed shortage special in summer season and receiving less than their maintenance. Thus, it is very important to increase the production of alfalfa through, improving agricultural practices, selecting the adapted varieties and suitable plant breeding program especial in the newly reclaimed soils of Egypt. Current change in the climatic conditions towards warming especially in Egypt are expected to prolong the summer season and shorten the winter or any season during which alfalfa is grown. Thus it was desirable to change the sowing date of alfalfa to avoid the high or low temperature effects at the beginning of the fall season which was studied by few workers.

Forage yield and its components is often influenced by weather conditions at the reproductive period. Cakmakci *et al.* (2004) in Turkey found that the best sowing date of alfalfa was at the last week of October. Mueller (2005) reported that based upon temperature and day length information, fall planting dates between September 15th and October 31st and spring planting dates between February 1st and March 15th have the greatest potential for successful stand establishment. On the other hand, Abdel-Galil and Hamed (2008) found significant differences among each of cultivars and years for all forage traits.

Variation in weather conditions at various stages of plant development may affect the differential response of genotypes to environments. Because of alfalfa genotypes are being grown under a wide range of conditions. So they are exposed to different soil types and fertility levels, moisture levels temperatures and cultural practices i.e. sowing date. All the variables encountered in producing alfalfa can be described collectively as the environment. Therefore, when the alfalfa genotypes are compared in different environments its performance relative to each other may not be the same. These changes in the relative performance of genotypes across different environments are referred to as genotype x environment interaction. Such information may be used to plan efficient breeding programs to develop more productive varieties or to improve crop management which might favour forage production as an economically competitive enterprise.

Little information is available in Egypt regarding the influence of temperature resulting from different sowing dates and the effect of genotype x environment interaction on forage yield production of alfalfa. With this respect, Bakheit (1988) found highly significant effects due to environments (locations x years), genotypes and their interactions on forage yield traits.

The objective of this study was undertaken to determine the influence of temperature conditions resulting from different sowing dates on the forage yield and its components, as well as study the stability of forage yield of alfalfa varieties under different environments such as sowing dates and seasons.

Materials and Methods

The present study was carried out at the Agronomy Department Experimental Farm, Faculty of Agriculture, South Valley University, Qena, Egypt, during two successive growing seasons of 2014/2015 and 2015/2016 to study the effect of temperature conditions resulting from different sowing dates of forage yield and its components of seven alfalfa varieties. The same physical and chemical properties of the experimental soil in 2014/2015 and 2015/2016 seasons are sand (82, 85%), silt (8, 11%), clay (10, 4%), soil pH (7.7, 8) organic matter (0.17, 0.15%), total N mg/kg (198, 34) and $CaCO_3$ (8.5, 9.7%), respectively.

The genetic materials for this study included six Egyptian alfalfa varieties namely: Aswan, Balady, El-Dakhla, Ismailia-1, Nitrogen fixed population, and Siwa namely Genan.

Three sowing dates of 20th October (D1), 20th November (D2) and 20th December (D3) were used for the seven alfalfa varieties in randomized complete block design with three replications for each sowing date in both seasons. Plot size was one meter square (3 meter long x 0.33 m apart). Alfalfa seeds were sown by hand at the rate of 10.0 g/m^2. Phosphorus was applied at level of 4 g P_2O_5/plot in the form of calcium super phosphate (P_2O_5 15.5%) before seeding. All cultural practices were maintained at optimum level for maximum alfalfa productivity. Three cuts were taken from each sowing date at 80, 125 and 165 days after sowing at 80, 45 and 40 days interval, respectively.

Data recorded:

The following traits were recorded at the time of each cut for each sowing date.

1- Plant height (cm) was determined from soil surface until the upper tip of plant. The average of five measurements for each plot at each cut and the average of three cuts were calculated.

2- Number of branches/plant, was determined at harvest for each cut as average of 5 plants, then the average of the three cuts were taken.

3- Leaves/stems ratio (fresh weight). A sample of fresh forage in each plot (about 200 gram) was hand separated to leaves and stems. Each component was weighed immediately to estimate the ratio, then the mean of three cuts were taken.

4- Fresh forage yield (kg/m^2) was determined by hand clipping of each plot and the total of three cuts were taken for each sowing date.

5- Dry forage yield (kg/m^2) was estimated by using, green forage yield of each plot x mean dry matter percentage, where dry matter percentage was determined from random samples of 150 gram from each plot at each cut, after drying in an oven at 70°C until weight constancy. The total of three cuts were taken.

6- Protein forage yield (kg/m^2) estimated by using dry forage yield/m^2 x protein percentage. The protein percentage was determined by the micro-kjeldahl method as outlined by A.O.A.C. (1980) to estimate the total nitrogen. Nitrogen percentage was multiplied by 6.25 to obtained crude protein.

Climatic data during the study period including maximum and minimum daily temperature relative humidity and photoperiod measured from sowing date to the third cut in each season and sowing date are presented in Table 1.

Table 1. Summary of daily temperature during the period of alfalfa growth in 2014/2015 and 2015/2016 seasons

Weather factor / Month		Average temperature °C						Average relative humidity %						Sun shine					
		2014/2015			2015/2016			2014/2015			2015/2016			2014/2015			2015/2016		
		Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Sun rise	Sun set	Day length	Sun rise	Sun set	Day length
Oct.	20-31	32.12	17.65	24.88	33.64	21.19	27.42	51.00	16.42	33.71	57.25	22.25	39.75	5:45	17:13	11:28	5:45	17:13	11:28
Nov.	01-10	32.07	17.33	24.70	29.31	16.60	22.96	50.17	16.08	33.13	64.52	26.19	45.35	5:45	17:12	11:26	5:45	17:12	11:26
	11-20	29.38	14.94	22.16	21.34	7.43	14.38	48.33	15.25	31.79	75.49	28.75	52.12	5:49	17:11	11:21	5:51	17:11	11:19
	21-30	24.96	12.1	18.53	27.92	13.29	20.61	47.92	14.58	31.25	71.37	26.65	49.01	5:54	17:10	11:16	5:54	17:10	11:16
Dec.	01-10	28.23	14.42	21.325	24.48	10.42	17.45	72.3	29.6	49.6	71.86	23.30	47.58	5:54	17:09	11:14	5:54	17:09	11:14
	11-20	25.58	12	18.79	21.93	9.12	15.53	71.2	28.2	51.15	81.49	30.44	55.97	5:55	17:09	11:13	5:55	17:09	11:13
	21-31	22.85	8.50	15.68	22.35	8.41	15.38	75.27	25.00	49.05	73.87	27.04	50.46	5:56	17:08	11:12	5:56	17:08	11:12
Jan.	01-10	18.52	6.26	12.39	21.34	7.43	14.38	66.9	27.1	48.15	75.49	28.75	52.12	5:56	17:07	11:10	5:56	17:07	11:10
	11-20	20.86	6.03	13.445	22.35	7.83	15.09	68	25.3	44.4	75.87	27.56	51.72	5:57	17:07	11:09	5:57	17:07	11:09
	21-31	26.95	10.63	18.79	18.63	5.85	12.24	52.64	20.64	36.91	74.41	30.13	52.27	5:58	17:06	11:08	5:58	17:06	11:08
Feb.	01-10	27.03	9.57	18.3	22.54	8.43	15.49	51.3	16.9	34.05	67.70	24.01	45.86	5:58	17:05	11:07	5:58	17:05	11:07
	11-20	21.72	9.45	15.59	28.33	11.20	19.77	51.92	18.33	35.13	52.73	16.50	34.61	5:59	17:05	11:06	5:59	17:05	11:06
	21-29	26.90	12.16	19.53	27.38	11.97	19.69	52.92	19.25	36.08	57.13	18.38	39.35	6:00	17:05	11:05	6:00	17:05	11:05
Mar.	01-10	30.14	14.07	22.105	30.60	14.60	22.60	53.7	13.7	33.15	47.55	12.80	30.30	6:00	17:04	11:03	6:00	17:04	11:03
	11-20	28.28	13.82	21.05	29.98	17.04	23.51	59.3	15.1	37.3	47.89	12.29	30.10	6:01	17:04	11:02	6:01	17:04	11:02
	21-31	32.22	17.34	24.78	30.65	16.21	23.43	33.45	9.18	21.55	44.91	12.64	28.78	6:02	17:03	11:01	6:02	17:03	11:01
Apr.	01-10	32.15	16.33	24.24	35.80	19.12	27.46	36.4	9.7	23.05	35.92	8.90	22.41	6:02	17:02	11:00	6:02	17:02	11:00
	11-20	28.97	13.68	21.33	34.58	19.57	27.07	29.78	9.56	19.67	35.30	8.99	22.15	6:03	17:02	10:58	6:03	17:02	10:58
	21-30	36.35	18.70	27.53	38.47	21.90	30.18	29.30	6.20	19.20	28.56	6.00	17.82	6:04	17:02	10:57	6:04	17:02	10:57
May	01-10	36.21	20.62	28.42	38.11	22.81	30.46	36.4	9.7	23.05	28.66	7.69	18.22	6:04	17:01	10:56	6:04	17:01	10:56
	11-20	36.70	21.60	29.15	41.01	24.31	32.66	29.78	9.56	19.67	26.97	5.75	16.36	6:05	17:01	10:55	6:05	17:01	10:55
	21-31	40.52	25.21	32.86	37.53	22.68	30.10	26.08	6.50	16.29	33.00	6.37	19.68	6:05	17:00	10:55	6:05	17:00	10:55
Jun.	01-10	40.9	24.85	32.875	43.74	27.94	35.00	28.7	7	17.5	22.92	5.34	14.13	6:06	17:00	10:54	6:06	17:00	10:54
	11-20	39.62	24.98	32.3	42.41	26.28	34.27	35.5	7.5	21.55	30.84	7.33	19.50	6:07	16:59	10:52	6:07	16:59	10:52
	21-30	38.47	25.15	31.81	42.30	27.71	35.00	36.1	9.1	22.95	32.99	8.36	21.46	6:07	16:59	10:51	6:07	16:59	10:51
Jul.	01-10	39.12	24.61	31.87	40.56	27.01	33.79	39.5	11.3	25.55	37.31	11.18	24.30	6:08	16:59	10:50	6:08	16:59	10:50
	11-20	39.99	25.57	32.78	40.48	26.80	33.64	37.2	9.9	22.35	33.72	11.01	22.37	6:09	16:59	10:49	6:09	16:59	10:49
	21-31	42.22	26.88	34.55	40.76	26.22	33.49	29.64	8.90	19.60	37.82	11.23	24.53	6:09	16:58	10:48	6:09	16:58	10:48

Source: Meteorological authority, Qena, Egypt

The total growing degree days (GDD), (base= 7°C) was calculated for each sowing date according to Saeed and Francis (1984) as follows:

Total growing degree days (GDD) = Σ[((Maximum + Minimum temperature)/2)-7]

Where: 7= Zero growth point from sowing date to the third cut continuous to seed maturity, (Table 2).

Table 2. Total growing degree day (GDD) for each sowing date and season at Qena where alfalfa trials were conducted.

Sowing date	Forage yield from sowing date until third cut	
	2014/2015	2015/2016
20th October	2033	1918
20th November	2027	2096
20th December	2370	2515

Statistical analysis:

For forage yield and its components in each sowing date over the three cuts, separate as well as combined analysis of variance were performed for the data over the sowing dates in each season and over the two seasons according to Gomez and Gomez (1984), whenever the homogeneity of variances between sowing dates and over the two seasons was detected. Means were compared using R.L.S.D. test at 5% level of probability.

Stability analysis:

Stability analysis was computed according to Tai (1971), where he suggested partitioning the genotype x environment interaction (GE) effect of the i^{th} variety into two components (α_i and λ_i). These estimates (α_i and λ_i) were computed for each of the seven varieties to compare the relative stability of varieties. The parameter α_i measures the linear response to the environmental effects and λ_i parameter measures the deviation from linear response in terms of the magnitude of the error variance. The two components are defined as genotypic stability parameters. The values (α=-1, λ=1) will be referred as perfect stability. However, the values (α= 0, λ=1) will be referred as average stability whereas the values (α>0 and λ=1) as below average stability. The hyperbola graph to test α's statistics and the limits of the confidence interval for λ's statistics were superimposed according to Tai (1971).

Results and Discussion

Seven alfalfa varieties were grown at three sowing dates (20^{th} at each of October, November and December) in 2014/2015 and 2015/2016 seasons to study the effect of the three different sowing dates on forage and seed yields and their components beside to acquaint the genotype x environment interaction for forage yield and its components. The sowing dates were used to evaluate the varieties performance in this study provided a range of variation in seasonal climate (Table 1). The climatic conditions i.e. average temperature, relative humidity and photoperiod (Table 1) and the total Growing Degree Days (GDD) were different during the two growing seasons for forage and seed yields (Table 2). The obtained results could be illustrated as following:

I- Performance of varieties under different sowing dates

I.1- Plant height:

Plant height is an essential factor in determining the forage yield for forage crops. Tuckak *et al*. (2008) reported that plant height is an important yield component and it is often used as a criterion when choosing superior genotypes in an early stage of selection.

The combined analysis of variance over the two seasons are shown in Table 3 and described that the sowing dates, genotypes, sowing dates x seasons, genotypes x seasons, sowing dates x genotypes, sowing x genotypes and sowing dates x genotypes x seasons interactions had a highly significant effects on plant height.

The average plant height in 2014/2015 and 2015/2016 seasons and their combined over the two seasons for the three sowing dates and seven genotypes are given in Table (4). The results revealed that the highest plant height was obtained from the plants sown in the third sowing date in both seasons, i.e. 48.29, 50.49 and 49.39 cm in the first, second and over the two seasons, respectively. The comparisons also showed that, the plant height was significantly decreased as sowing date was early from December 20th. On the other hand, plants sown at 20th November produced the shortest significant plant height of 42.66, 42.85 and 42.76 cm in the first, second and over the two seasons, respectively. This result could be due to climatological conditions prevailing during this period (Table 1).

Data in Table (4) also show that Ismailia-1 under the third date significantly gave the tallest plant height over the three sowing dates in the first, second, and over the two seasons, while the American variety (Genan) gave the shortest plant height in first, second, and over the two seasons. These results may be due to the genetic variability among the tested genotypes and response of each to the environmental conditions during the growing seasons which were suitable for Ismailia-1, Balady and Aswan than the other tested genotypes. Considering the significant interaction in the first season, data showed that Ismailia variety gave the longest plants (53.99) in the third date, while in the second season the Aswan variety in the third date gave the longest one (54.62). Moreover, the combined data over the two seasons indicated that Ismailia variety in the third date gave the longest one (53.48). These results are in agreement with those reported by Oushy *et al*. (1999a), Hefiny (2007), Abdel-Galil and Hamed (2008) and HamdAlla (2012). They found a significant difference among alfalfa genotypes and between years for plant height.

It could be noticed that the tallest plant heights of 53.99, 52.98 and 53.48 cm and 49.70, 53.06 and 51.38 cm were obtained by sowing Ismailia-1 and Balady populations at the December 20th in 2014/2015, 2015/2016 and over the two seasons, respectively.

I.2- Number of branches/plant:

Number of branches/plant is an essential factor in determining the forage yield for forage crops. Sengul (2002) considered number of branches/plant as forage yield components.

The combined analysis of variance for number of branches/plant over the two seasons is shown in Table 3. The results showed highly significant differences between seasons, and sowing dates for number of branches/ plant. While, significant difference between varieties was observed. In addition, significant interactions effects were observed for sowing dates x seasons, varieties x seasons and sowing dates x varieties x seasons. This may be due to the large differences in climatic conditions prevailing in these sowing dates and seasons.

The average number of branches/plant in 2014/2015, 2015/2016 and over the two seasons as affected by sowing dates and varieties are presented in Table 5.

Table 3. Combined analysis of variance for forage yield and its components of seven alfalfa varieties under three different sowing dates over the two seasons.

SOV	d.f	Mean Square					
		Plant height (cm)	Number of branches/ plant	Leaves/ stems ratio	Seasonal fresh forage yield (kg/m^2)	Seasonal dry forage yield (kg / m^2)	Seasonal protein forage yield (kg/m^2)
Year (Y)	1	53.10	5.31**	2.21**	40.05**	7.72**	0.46**
Error (a)	4	19.00	0.06	0.01	0.99	0.02	0.003
Sowing date (D)	2	465**	12.71**	0.21**	15.79**	0.79	0.08**
Y x D	2	10.96**	3.83*	0.16**	0.49	0.20	0.01
Error (b)	8	10.58	0.77	0.01	1.30	0.89	0.06
Varieties (V)	6	78.6**	2.54*	0.10**	15.30**	1.03*	0.09**
V x Y	6	16.8**	2.28*	0.03*	3.09**	0.16	0.008
Y x D	12	12.3*	1.75	0.04**	1.52**	0.15	0.03**
Y x D x Y	12	15.1**	1.03*	0.03*	1.77**	0.22**	0.01
Error (c)	72	4.38	0.38	0.01	0.43	0.10	0.007

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

Table 4. Mean Plant height (cm) of seven alfalfa varieties under each sowing dates in 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	44.32	49.20	44.74	43.98	47.18	38.29	45.87	44.80
	D2	43.93	44.16	43.23	44.87	40.01	39.41	43.02	42.66
	D3	47.49	49.70	45.79	53.99	47.77	45.72	47.54	48.29
	Mean	45.25	47.69	44.59	47.61	44.99	41.14	45.48	45.25
	RLSD 5% for								
	Sowing date (D)	2.00							
	Variety (V)	1.99							
	V x D	3.78							
2015/2016	D1	51.46	45.74	44.34	46.66	46.38	44.02	45.47	46.29
	D2	45.06	44.33	42.38	43.17	41.22	41.21	42.61	42.85
	D3	54.63	53.06	52.03	52.98	51.40	43.13	46.20	50.49
	Mean	50.38	47.71	46.25	47.60	46.33	42.79	44.76	46.55
	RLSD 5% for								
	Sowing date (D)	2.23							
	Variety (V)	1.76							
	V x D	3.62							
Combined over two seasons	D1	47.89	47.47	44.54	45.32	46.78	41.16	45.67	45.55
	D2	44.49	44.25	42.81	44.02	40.62	40.31	42.82	42.76
	D3	51.06	51.38	48.91	53.48	49.58	44.43	46.87	49.39
	Mean	47.81	47.70	45.42	47.61	45.66	41.96	45.12	45.90
	RLSD 5% for								
	Sowing date (D)	1.51			**Y x D**	1.3			
	Variety (V)	1.26			**Y x V**	1.45			
	V x D	2.71			**YxVxD**	3.62			

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December.

Table 5. Mean branch number of seven alfalfa varieties under each sowing dates in 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	5.78	6.67	6.53	6.73	7.59	6.09	6.92	6.62
	D2	6.69	6.42	6.34	7.14	6.83	6.98	6.93	6.76
	D3	6.49	6.21	6.40	8.34	7.11	7.07	7.09	6.96
	Mean	6.32	6.43	6.43	7.41	7.18	6.71	6.98	6.78
	RLSD 5% for								
	Sowing date (D)	-							
	Variety (V)	0.34							
	V x D	0.65							
2015/2016	D1	6.97	6.38	6.67	6.64	6.49	6.93	7.06	6.73
	D2	6.93	6.99	6.36	6.60	6.51	7.41	6.32	6.73
	D3	7.84	7.44	7.49	8.34	7.90	7.24	7.20	7.64
	Mean	7.25	6.94	6.84	7.20	6.97	7.20	6.86	7.03
	RLSD 5% for								
	Sowing date (D)	0.36							
	Variety (V)	--							
	V x D	--							
Combined over two seasons	D1	6.37	6.52	6.60	6.69	7.04	6.51	6.99	6.67 B
	D2	6.81	6.71	6.35	6.87	6.67	7.19	6.63	6.75 B
	D3	7.17	6.83	6.94	8.34	7.51	7.16	7.14	7.20 A
	Mean	6.78	6.69	6.63	7.30	7.07	6.95	6.92	6.91
	RLSD 5% for								
	Sowing date (D)	0.27			**Y x D**	0.38			
	Variety (V)	0.47			**Y x V**	0.69			
	V x D	-			**YxVxD**	1.002			

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December. - F value not significant.

The highest number of branches/plant of 6.96, 7.64 and 7.20 were obtained from plants sown on December 20th in 2014/2015, 2015/2016 and over the two seasons, respectively. On the other hand, no significant differences were detected in number of branches/plant in both seasons between sowing dates at October 20th and November 20th.

Comparison between the number of branches/plant of the seven varieties over all sowing dates, revealed that Ismailia-1 variety produced the highest number of branches/plant of 7.41 and 7.30 in the first and over the two seasons, respectively, whereas, Aswan variety gave the highest number of branches (7.25) in second season.

It was also evident that Ismailia-1 sown on December 20th produced the highest number of branches/plant of 8.34 in 2014/2015, 2015/2016 and over the two seasons.

Considering the significant interactions, the observed data (Table 5) indicated that Ismailia variety in the third date had the highest number of branches in the first season, and also over the two seasons (8.34).

These results are in line with those obtained by Mousa *et al.* (1996), Abdel-Galil and Hamed (2008) and HamdAlla (2012) who found a significant differences among alfalfa genotypes and between years for number of branches/plant.

I.3- Leaves/stem ratio:

Leaves/stem ratio is one of the essential factors in determining the forage quality and palatability in forage crops.

The combined analysis of variance over the two seasons (Table 3) revealed that the season had a highly significant effect on leaves/stems ratio. This may be due to the difference between the two seasons in climatic conditions as mention before (Table 2). Also, highly significant differences among sowing dates and varieties were obtained. Moreover, the mean squares for sowing dates x seasons and sowing dates x varieties interactions were highly significant. Meanwhile, the mean squares for varieties x seasons and sowing dates x varieties x seasons interactions were significant (Table 3).

The average leaves/stems ratio as affected by sowing dates and varieties in 2014/2015 and 2015/2016 seasons and combined over the two seasons are presented in Table 6. Comparisons among the three planting dates show that, sowing at November 20th gave the highest mean values of leaves/stem ratio which were 1.87, 1.57, and 1.72 in 2014/2015, 2015/2016 and over the two seasons, respectively. Moreover, the results indicated that leaves/stems ratio decreased and reached the minimum value at the first sowing date (October 20th) in first and over the two seasons.

Comparing the average leaves/stems ratio of the different varieties over all sowing dates, it be noticed that Genan American population produced the highest leaves/stems ratio as compared with the other tested varieties in both seasons and over the two seasons. On the other hand, Aswan population produced the lowest leaves/stems ratio of 1.67, 1.43, and 1.55 in 2014/2015, 2015/2016 and over the two seasons, respectively. Moreover, Genan population gave the highest leaves/stems ratio of 2.00, 1.64 and 1.82 which were obtained when sowing was performed on November 20th in first, second and over two seasons, respectively.

Considering the significant interaction in both separate and combined analyses, the data in Table (6) indicated that Siwa population had the highest leaves/stem ratio in the first season, while Genan population had the highest one in the second season. Also, Genan population had the highest leaves stem ratio over the two seasons.

These results confirm the genetic variation reported by Bakheit (1988), Rammah *et al*. (1988). Abdel-Halim *et al*. (1992), Mousa *et al*. (1996), Abdel-Galil and Hamed (2008) and HamdAlla (2012).

I.4- Seasonal fresh forage yield (kg/m^2)

The combined analysis of variance for seasonal fresh forage yield over the two seasons are shown in Table 3. The mean squares of combined analysis revealed that seasons, sowing dates and varieties had a highly significant effects. Moreover, the mean squares for sowing dates x varieties, sowing dates x seasons, and sowing dates x varieties x seasons interactions were statistically highly significant. The presence of these interactions suggested a differential response of varieties to varied sowing dates. Also, this might indicate, variable varietal response from year to another. These results are in line with obtained by Oushy *et al*. (1999b), Hefiny (2007), Abdel-Galil and Hamed (2008) and HamdAlla (2012). They found that a significant difference among alfalfa varieties and between years for fresh and dry forage yields.

The seasonal fresh forage yield (kg/m^2) as influenced by sowing dates and varieties in 2014/2015, 2015/2016 and over the two seasons are presented in Table 7. The results in Table 6 show that the maximum seasonal fresh forage yield (kg/m^2) of 4.73, 6.02 and 5.38 kg/m^2 which were obtained from sowing on December 20th in 2014/2015, 2015/2016 and over the two seasons, respectively. This results may be due to the more accumulative forage yield in this period depending on the optimum clamite conditions.

The results also, show that the seasonal fresh forage yield was significantly increased as sowing date was delayed. This may be due to the temperature and other climatic conditions at the December 20th were favorable for alfalfa crop in Quena Governorate and this may be suitable for seed germination. On the other hand, the decrease of seasonal fresh forage yield at early planting date in October 20th and November 20th may be due to the high temperature and insect attack in this time and consequently the death of some seedlings. These results are in agreement with those obtained by Shannon (2005) who found that temperature and photoperiod influence alfalfa seedling development.

Concerning the effect of varieties on the seasonal fresh forage yield, Ismailia-1 variety produced the highest fresh forage yield of 5.17 kg/m^2 in 2014/2015 season. While, Aswan population produced the highest fresh forage yield of 6.58 and 5.50 kg/m^2 in 2015/2016 and over the two seasons, respectively. This may be due to the climatic condition of Qena as the same of climatic conditions of Aswan. Thereby the Aswan population outyielded other varieties Qena governorate. In general, all most the studied varieties had the highest seasonal fresh forage yield when they were sown on December 20th as revealed in both seasons.

Table 6. Mean leaves/stems ratio for seven alfalfa varieties under each sowing dates of 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	1.50	1.63	1.55	1.66	1.71	1.82	1.64	1.65
	D2	1.78	1.79	1.79	1.85	2.03	2.00	1.87	1.87
	D3	1.72	1.49	1.99	1.94	1.92	1.94	2.04	1.86
	Mean	1.67	1.64	1.78	1.82	1.89	1.92	1.85	1.79
	RLSD 5% for								
	Sowing date (D)								0.06
	Variety (V)								0.11
	V x D								0.23
2015/2016	D1	1.34	1.50	1.65	1.57	1.49	1.49	1.59	1.53
	D2	1.50	1.59	1.49	1.65	1.58	1.64	1.53	1.57
	D3	1.45	1.41	1.58	1.34	1.40	1.66	1.65	1.50
	Mean	1.43	1.50	1.57	1.52	1.49	1.59	1.59	1.53
	RLSD 5% for								
	Sowing date (D)								--
	Variety (V)								0.01
	V x D								0.19
Combined over two seasons	D1	1.42	1.57	1.60	1.62	1.60	1.66	1.62	1.58
	D2	1.64	1.69	1.64	1.75	1.80	1.82	1.70	1.72
	D3	1.58	1.45	1.78	1.64	1.66	1.80	1.85	1.68
	Mean	1.55	1.57	1.67	1.67	1.69	1.76	1.72	1.66
	RLSD 5% for								
	Sowing date (D)	0.05				**Y x D**			0.07
	Variety (V)	0.07				**Y x V**			0.11
	V x D	0.13				**YxVxD**			0.22

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December. - F value not significant.

Table 7. Mean seasonal fresh forage yield (kg/m^2) for the seven alfalfa varieties under each sowing dates in 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	4.59	4.05	4.34	5.01	3.99	1.92	3.27	3.88
	D2	4.58	5.30	4.42	4.45	2.46	1.35	3.38	3.70
	D3	4.08	5.19	4.34	6.06	5.72	2.58	5.15	4.733
	Mean	4.42	4.84	4.37	5.17	4.06	1.95	3.93	4.11
	RLSD 5% for								
	Sowing date (D)								-
	Variety (V)								0.64
	V x D								1.37
2015/2016	D1	5.51	4.96	4.51	4.71	4.62	3.80	5.23	4.76
	D2	6.93	4.30	7.00	3.04	4.02	3.21	4.05	4.65
	D3	7.30	6.38	7.50	6.26	5.64	4.22	4.86	6.02
	Mean	6.58	5.22	6.34	4.67	4.76	3.74	4.71	5.14
	RLSD 5% for								
	Sowing date (D)								0.60
	Variety (V)								0.49
	V x D								0.93
Combined over two seasons	D1	5.05	4.50	4.43	4.86	4.30	2.86	4.25	4.32
	D2	5.75	4.80	5.71	3.74	3.24	2.28	3.71	4.18
	D3	5.69	5.79	5.92	6.16	5.68	3.40	5.01	5.38
	Mean	5.50	5.03	5.35	4.92	4.41	2.85	4.32	4.63
	RLSD 5% for								
	Sowing date (D)	0.52					**Y x D**		-
	Variety (V)	0.39					**Y x V**		0.41
	V x D	0.77					**YxVxD**		1.09

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December. - F value not significant.

The second growing season (2015/2016) gave higher values than the first one (2014/2015) for seasonal fresh forage yield in all varieties. This might explain the reason for significant year x variety interaction. These results confirm the genetic variation within and among the studied genotypes. These results are in agreement with those reported by Bakheit (1988), Rammah *et al*. (1988), Abdel-Halim *et al*. (1992), Abdel-Galil and Hamed (2008).

Concerning the significant interactions in the separate and combined analyses, the data of Table (7) showed that Ismailia population was the best (6.06) in the third date of the first season, while the Dakhla population was the best in the second season for this trait (7.50). On the other hand, Dakhla population was the best in the third date of the second season.

The combined data over the two seasons, reveal that, sowing date at December 20th produced the highest seasonal fresh forage yield i.e. 5.38 kg/m^2. Furthermore, it is evident that Aswan population produced the maximum seasonal fresh forage yield of 5.50 kg/m^2. This is to be logic since the same sowing date produced the highest mean value of plant height and number of branches/plant and consequently produced the high forage yield.

I.5- Seasonal dry forage yield (kg/m^2)

The combined analysis of variance (Table 3) revealed highly significant differences among seasons. Also, the mean square for this trait revealed significant differences between the seven varieties of alfalfa. Moreover, the mean square for sowing dates x varieties x seasons interaction was statistically highly significant (Table 3).

The average of seasonal dry forage yield as influenced by sowing dates and varieties in 2014/2015 and 2015/2016 seasons and over two seasons are shown in Table 8.

In 2014/2015 and 2015/2016 seasons data showed that seasonal dry forage yield varied from 1.50 to 1.87 kg/m^2 for sowing date at December 20th and from 1.16 to 1.79 kg/m^2 for sowing date at October 20th in the first and second seasons, respectively. Also, this trait varied from 1.58 to 2.11 kg/m^2 for Aswan population and from 0.83 to 1.45 kg/m^2 for Ganan American population in first and second seasons, respectively.

In addition, the combined over the two seasons for seasonal dry forage yield varied from 1.68 in the third sowing date (December 20th) to 1.43 kg/m^2 in the second sowing date with an average of 1.53 kg/m^2.

It is evident that the maximum seasonal dry forage yield of 1.50, 1.87 and 1.68 kg/m^2 were obtained when sowing was performed at December 20th in 2014/2015, 2015/2016 and over the two seasons, respectively. Seasonal dry forage yield increased as sowing date was delayed in both seasons. This is logic since the same sowing date produced the highest mean value of fresh forage yield, plant height and number of branches/plant and consequently produce the highest dry forage yield.

The highest seasonal dry forage yield at late sowing dates may be due to the high temperature and consequence the high dry matter percentage in cutting of this late planting date, and the high fresh forage yield at this sowing date. These results are in line with that reported by Cakmakci *et al*. (2004) in Turkey, who found that the best sowing date of alfalfa was the last week of October.

On the other hand, in both seasons, no significant differences were noticed in seasonal dry forage yield between three sowing dates.

Concerning the effect of varieties on the seasonal dry forage yield, Aswan population produced the highest dry forage yield of 1.58 and 2.11 kg/m^2 in 2014/2015 and 2015/2016 seasons, respectively. While, Ganan American population produced the lowest one of 0.83 and 1.45 kg/m^2 in the same seasons, respectively.

These results are in line with those reported by Abdel-Halim *et al*. (1992 and 1998), Mousa *et al*. (1996), Geweifel (1997), Oushy *et al*. (2007), Abdel-Galil and Hamed (2008), HamdAlla *et al*. (2013) and Ibrahim *et al*. (2014) whom reported that significant differences were noticed in seasonal dry forage yield between alfalfa varieties. It could be noticed that the highest seasonal dry forage yield of 1.61 and 2.27 kg/m^2 was obtained by sowing Aswan population at the December 20th in 2014/2015 and 2015/2016 seasons, respectively.

I.6- Seasonal protein forage yield:

The combined analysis of variance (Table 3) revealed highly significant differences among seasons and varieties. Moreover, the mean squares for varieties x sowing dates interaction only was highly significant.

The average of seasonal protein yield as influenced by three sowing dates and seven alfalfa varieties in 2014/2015, 2015/2016 seasons and over the two seasons are shown in Table 9. The results showed that the seasonal protein forage yield varied from 0.36 to 0.45 for sowing date at December 20th and from 0.24 to 0.39 kg/m^2 for sowing date at October 20th in the first and second seasons, respectively. With an average of 0.30 and 0.42 kg/m^2 for all sowing dates in the first and second seasons, respectively. Also, this trait varied from 0.41 to 0.55 kg/m^2 for Aswan population but from 0.18 to 0.34 kg/m^2 for Genan American population, for the first and second season, respectively. In addition, combined over the two seasons, the seasonal protein forage yield varied from 0.40 in the third sowing date (December 20th) to 0.32 kg/m^2 in the first sowing date (October 20th) with an average of 0.36 kg/m^2. On the other hand, the maximum seasonal protein forage yield of 0.36, 0.45 and 0.40 kg/m^2 were obtained when sowing was performed at December 20th in 2014/2015, 2015/2016 and over the two seasons, respectively. This mean that the seasonal protein forage yield increased as sowing date was delayed in both and over the two seasons.

The highest seasonal protein forage yield at late planting dates may be due to the high temperature consequence the high dry matter percentage in cutting of this late sowing date.

Table 8. Mean seasonal dry forage yield (kg/m^2) for seven the alfalfa varieties under each sowing dates in 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	1.34	1.10	1.35	1.09	1.15	1.08	0.97	1.16
	D2	1.79	1.30	1.24	1.42	0.94	0.51	1.08	1.18
	D3	1.61	1.54	1.55	1.56	1.70	0.89	1.69	1.50
	Mean	1.58	1.31	1.38	1.36	1.26	0.83	1.25	1.28
	RLSD 5% for								
	Sowing date (D)	-							
	Variety (V)	0.33							
	V x D	-							
2015/2016	D1	1.93	1.94	1.83	1.60	1.90	1.44	1.90	1.79
	D2	2.13	1.57	2.31	1.29	1.38	1.64	1.37	1.67
	D3	2.27	1.89	2.46	1.97	1.74	1.26	1.47	1.87
	Mean	2.11	1.80	2.20	1.62	1.67	1.45	1.58	1.78
	RLSD 5% for								
	Sowing date (D)	-							
	Variety (V)	0.31							
	V x D	0.51							
Combined Over two seasons	D1	1.64	1.52	1.59	1.35	1.52	1.26	1.44	1.47
	D2	1.96	1.43	1.78	1.35	1.16	1.07	1.23	1.43
	D3	1.94	1.71	2.00	1.76	1.72	1.08	1.58	1.68
	Mean	1.85	1.56	1.79	1.49	1.47	1.14	1.41	1.53
	RLSD 5% for								
	Sowing date (D)	-			**Y x D**	-			
	Variety (V)	0.19			**Y x V**	-			
	V x D	-			**YxVxD**	0.7			

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December. - F value not significant.

Table 9. Mean seasonal protein forage yield for seven alfalfa varieties under each sowing dates in 2014/2015, 2015/2016 and over the two seasons.

Season	Sowing date	Populations							
		Aswan	Balady	Dakhla	Ismailia	Nitro-gen Fixed	Genan	Siwa	Mean
2014/2015	D1	0.29	0.23	0.31	0.19	0.27	0.19	0.22	0.24
	D2	0.55	0.29	0.36	0.34	0.21	0.15	0.26	0.31
	D3	0.39	0.37	0.34	0.41	0.39	0.21	0.40	0.36
	Mean	0.41	0.30	0.34	0.31	0.29	0.18	0.29	0.30
	RLSD 5% for								
	Sowing date (D)	-							
	Variety (V)	0.1							
	V x D	-							
2015/2016	D1	0.44	0.41	0.38	0.30	0.35	0.39	0.45	0.39
	D2	0.65	0.34	0.67	0.36	0.39	0.32	0.34	0.44
	D3	0.55	0.43	0.54	0.52	0.41	0.30	0.37	0.45
	Mean	0.55	0.39	0.53	0.39	0.38	0.34	0.39	0.42
	RLSD 5% for								
	Sowing date (D)	-							
	Variety (V)	0.05							
	V x D	0.1							
Combined over two seasons	D1	0.37	0.32	0.34	0.25	0.31	0.29	0.34	0.32
	D2	0.60	0.31	0.51	0.35	0.30	0.24	0.30	0.37
	D3	0.47	0.40	0.44	0.46	0.40	0.25	0.39	0.40
	Mean	0.48	0.35	0.43	0.35	0.34	0.26	0.34	0.36
	RLSD 5% for								
	Sowing date (D)	-			**Y x D**	-			
	Variety (V)	0.05			**Y x V**	-			
	V x D	0.131			**YxVxD**	-			

D1= Sowing date at 20th October. **D2**= Sowing date at 20th November.
D3= Sowing date at 20th December. - F value not significant.

Concerning the effect of varieties on the seasonal protein forage yield, Aswan population produced the highest seasonal protein forage yield of 0.41, 0.55, and 0.48 kg/m^2 in 2014/2015, 2015/2016 and over the two seasons, respectively. While, Genan American population produced the lowest seasonal protein forage yield of 0.18, 0.34 and 0.26 kg/m^2 in the same manner.

Comparison between the seasonal protein forage yield of the different sowing dates and varieties, it could be noticed the Aswan population produced the highest seasonal protein forage yield at December 20th sowing date in first, second, and over the two seasons.

On the other hand, Genan American population produced the lowest seasonal protein forage yield at October 20th sowing date in the same seasons. This is to be logic since the same sowing date produced the highest mean values of plant height, number of branches/plant, fresh forage yield, dry and protein forage yields.

II- Stability analysis

Analysis of variance across varieties and environments (sowing dates x seasons) (Table 10) indicated that the sowing dates, varieties and varieties x sowing dates (GE) interactions were significant for plant height, number of branches/plant and fresh, dry and protein forage yields. While the leaf/stem ratio was not significant (Table 10). This revealed that there was considerable variability among studied varieties as well as sowing dates. On the other hand, the environment mean square was significant indicating that the three sowing dates in the two seasons provided a sufficient range of environments and hence the validating of environment requirements suggested by Tai (1971) were fulfilled. The results are in broad agreement with reported by Bakheit (1988) of alfalfa and Bakheit *et al*. (2017) in Egyptian clover.

II.1- Plant height

The mean plant heights for varieties under six environments (three sowing dates x two seasons) are shown in Table 11. The values ranged from 41.96 cm for Genan population to 47.81 cm for Aswan population. The populations of Aswan, Balady and Ismailia were significantly taller than the rest.

The data in Table 11 revealed that the varieties greatly differed in the amount of deviation from the linear response (λ) and to a less extent in the linear response (α). Aswan, Ismailia and Genan genotypes had significant λ values. Aswan followed by Genan and Ismailia populations had the highest λ values. Therefore they were unstable. The distribution of a α and λ values (Fig. 1a) indicated that the stability area contained Balady, Dakhla, Siwa and Nitrogen fixed population. Therefore these populations were the most stable ones.

II.2- Number of branches/ plant

Mean number of branches/plant and stability parameters of the different populations over the six environments are presented in Table 11 and graphically plotted in Fig. 1b. The mean number of branches/plant ranged from 6.63 for Dakhla population to 7.30 for Ismailia population. The Ismailia population was significantly higher in number of branches/plant than Aswan, Balady and Dakhla populations. All seven populations were not significantly different in the amount of deviation from the linear response (λ). Fig. 1b shows that all populations were located in the area of average stability region except Dakhla population which was near stability region.

II.3- Fresh forage yield

Fresh forage yield for the seven populations over all environments ranged from 2.85 kg/m^2 for Genan population to 5.50 kg/m^2 for Aswan population (Table 11). The superior populations in fresh forage yield were Aswan and Dakhla populations which significantly outyielded the Ismailia, Nitrogen fixed, Genan and Siwa populations (Table 11).

The populations greatly differed in the amount of deviation from the linear response (α value) and in the linear response (λ value) for fresh forage yield (Table 11). The great variation in the estimates suggested that the relatively unpredictable component of the cultivar x environment interaction variance may be more important than the relatively predictable component of variation for those populations. Moreover, the populations showed different degrees of stability. Similar conclusions were reached by Tai (1971) in potato, Bakheit (1985) and Bakheit *et al*. (2017) in Egyptian clover. All populations except Ismailia and Genan populations had significant λ values. Some of those populations viz. Aswan, Dakhla and Balady populations were the highest for fresh forage yield but they were unstable.

The average stability area for fresh forage yield (Fig. 1c) contained the populations of Ismailia and Genan. On the other hand, Genan population was located in the above average stability region, but Ismailia population was below the average stability region.

II.4- Dry forage yield

The mean dry forage yield and stability parameters of the different populations over the six environments are presented in Table 11 and graphically plotted in Fig. 1d. It ranged from 1.14 kg/m^2 for Genan population to 1.85 kg/m^2 for Aswan population. The superior population in dry forage yield was Aswan population which significantly outyielded the other populations except Balady population.

Table 10. Stability analysis of variance for forage yield and its components of seven alfalfa genotypes under different environments.

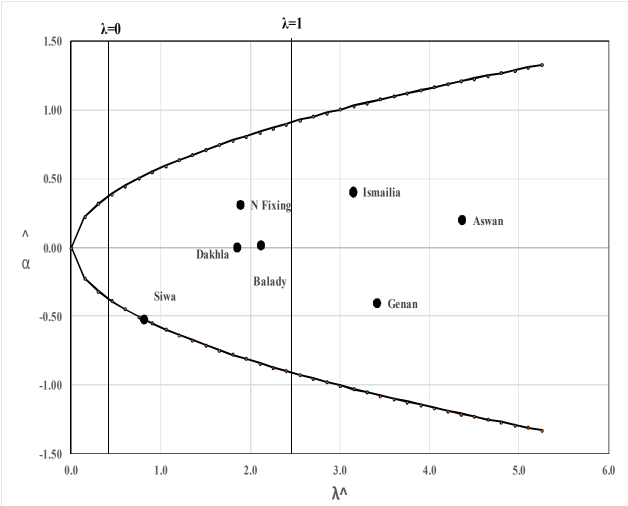
Source of variation	d.f	Mean Squares for: Plant height (cm)	Branch number	Leaf/stem ratio	Fresh forage yield (kg/m^2)	Dry forage yield (kg/m^2)	Protein forage yield (kg/m^2)
Environment (E)	5	201.17**	2.95**	0.59**	14.51**	1.94*	0.13*
Rep./Envir.	12	13.38	0.53	0.009	1.19	0.6	0.04
Varieties (V)	6	78.58**	2.54**	0.1	15.29**	1.03**	0.09**
V x E	30	14.30**	1.57**	0.032	1.93**	0.18**	0.02**
Error	72	4.38	0.38	0.85	0.43	0.095	0.010

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

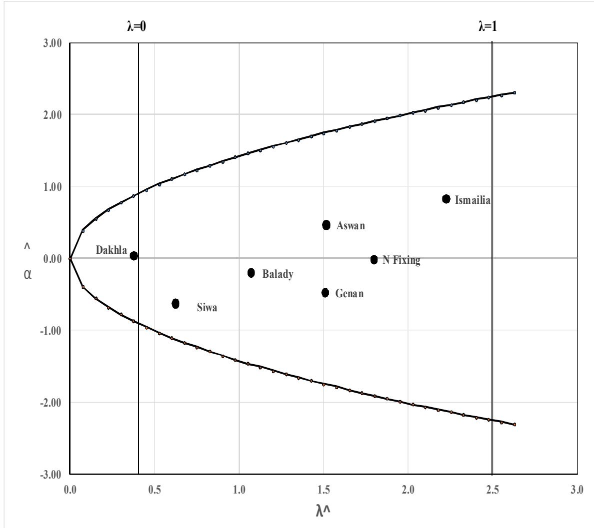
Table 11. Mean performance over six environments ($\overline{X}$) and stability parameters (α, λ) of seven alfalfa varieties for plant height, branch number, leaf /stem ratio and fresh dry and protein forage yield (kg/m^2).

Traits / Varieties	Plant height (cm)			Branch number			Leaf/stem ratio			Fresh forage yield (kg/m^2)			Dry forage yield (kg/m^2)			Protein forage yield (kg/m^2)		
	$\overline{X}$	α	λ	$\overline{X}$	α	λ	$\overline{X}$	α	λ	$\overline{X}$	α	λ	$\overline{X}$	α	λ	$\overline{X}$	α	λ
Aswan	47.81	0.20	4.37*	6.78	0.47	1.52	1.55	-0.04	0.74	5.5	0.27	5.83*	1.85	-0.13	1.5	0.48	0.30	3.98
Balady	47.7	0.02	2.12	6.69	-0.20	1.07	1.57	-0.56	3.58*	5.03	-0.40	3.28*	1.56	0.04	0.34	0.35	-0.26	0.78
Dakhla	45.42	0.00	1.86	6.63	0.04	0.38	1.67	-0.11	3.47*	5.35	0.44	6.61*	1.79	0.64	1.97	0.43	0.62	3.20
Ismailia	47.61	0.4	3.15*	7.30	0.82	2.22	1.67	0.16	2.22	4.92	-0.38	2.11	1.49	-0.41	1.42	0.35	0.08	2.29
Fixed	45.66	0.31	1.89	7.07	-0.02	1.80	1.69	0.46	0.58	4.41	0.13	4.96*	1.47	0.08	1.36	0.43	-0.26	1.06
Genan	41.96	0.41	3.41	6.95	-0.48	1.51	1.76	0.08	1.66	2.85	0.23	1.62	1.14	-0.07	2.98	0.26	0.17	1.98
Siwa	45.12	0.52	0.81	6.92	-0.63	0.63	1.72	0.01	2.39	4.63	-0.29	3.23*	1.41	-0.15	1.86	0.34	0.31	1.91
R.L.S.D.	1.26			0.47			0.07			0.39			0.19			0.05		

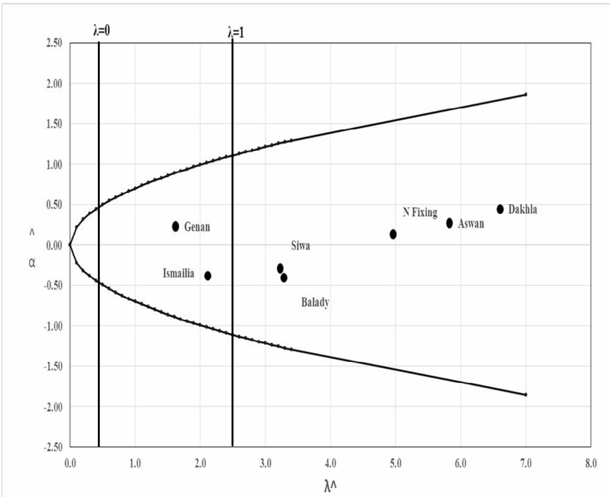
* λ value greater than Fa value derived from F table with n_1= 4, n_2= 72 and a= 0.05
n_1= Number of environment-2. n_2= Degree of freedom for error.
a= Level of probability



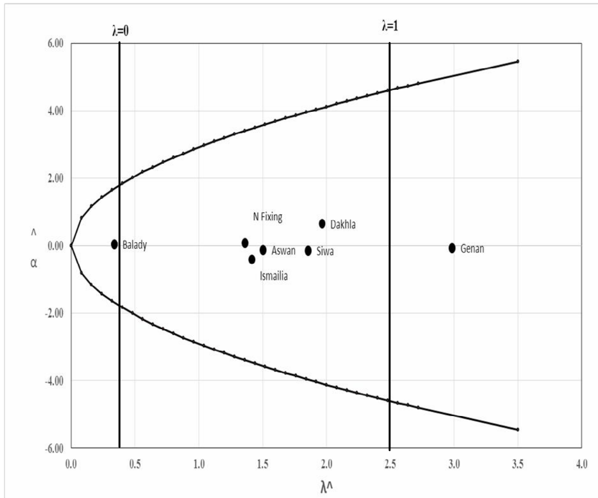
a- Plant height



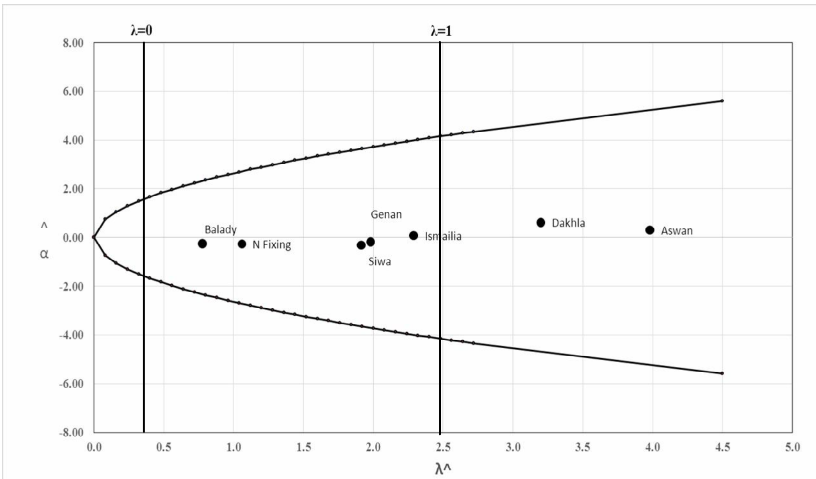
b- Number of branches/plant



c- Fresh forage yield



d- Dry forage yield



e- Protein forage yield

Fig. 1. Distribution of estimates of genotypic stability parameters of seven alfalfa varieties.

Genan population only significantly differed in the amount of deviation from the linear response (λ).

Fig. 1d shows that all populations were located in the area of average stability except Genan population which was unstable. The Aswan and Dakhla populations were distributed in the average stability region and showed the highest dry forage yield. These populations can be used as a source for dry forage yield improvement in breeding programmes.

II.5- Protein forage yield

Protein forage yield for the seven populations over all environments ranged from 0.26 kg/m^2 to 0.48 kg/m^2, Table 11. The lowest and highest populations in protein forage yield were Genan and Aswan, respectively. The superior populations in protein forage yield were Aswan and Dakhla which significantly outyielded the other populations.

The populations greatly different in the amount of deviation from the linear response (α values) and to a less extent in the linear response (λ value) for protein forage yield (Table 11). The great variation in the estimates suggested that the relatively unpredictable component of the population x environment interaction variance may be more important than the relatively predictable component of variation for those populations. Moreover, the populations showed different degrees of stability. Similar conclusions were reached by Tai (1971) in potato, Bakheit (1985) and Bakheit *et al*. (2017) in Egyptian clover and Bakheit (1988) in alfalfa. The Aswan and Dakhla populations had significant λ values and they were the highest for protein forage yield, but they were unstable.

The average stability area for protein forage yield (Fig. 1e) contained all populations except Aswan and Dakhla populations. The highest yielding populations were unstable. It is worth to mention that the populations of Balady, Ismailia, Nitrogen fixed, Genan, and Siwa which were below the average in yield showed nearly perfect stability (α= -0.26, 0.08, -0.26, 0.17, and 0.31 and λ= 0.78, 2.29, 1.06, 1.98 and 1.91, respectively) and were located in the average stability region of the stability graphic presentation.

Tai (1971) proposed that the ideal genotype is the one which has the highest yields over a broad range of environments, α= 0, λ= 1. Many reports provide correlations between mean yields and stability parameters i.e. Eberhart and Russell (1966), Tai (1971, 1979), Bakheit (1985 and 1988) and Bakheit *et al*. (2017). For example Bakheit (1988) in alfalfa reported that the high yielding ability genotypes were unstable over environments and those possessed average stability were generally low in productivity. Results obtained in the present investigation showed clearly the same conclusion.

For the practical utility of these results there are different choices. It may be possible to select a high forage yielding population which shows relatively low level of stability such as Aswan population (protein forage yield = 0.48 kg/m^2, α= 0.30, and λ= 3.98*) as source of high yielding genes to be crossed with the below average yielding populations such Nitrogen fixed population (protein forage yield= 0.34 kg/m^2, α= -0.26 and λ= 1.06) as source for stability genes. Thereafter, selection could be practiced for population with high yielding ability and average stability as some investigators reported that stability index is a heritable trait (Finley & Wilkinson, 1963; Finley, 1971; Bucio Alanis & Hill, 1966 and Perkins & Jinks, 1968a,b).

Furthermore, it could also be noticed that the Ismailia population had fresh, dry and protein forage yields of 4.92, 1.49 and 0.35 kg/m^2, respectively, and number of branches/plant of 7.30. This entry was distributed in the average stability region for number of branches/plant. Such genotypes may be used as high number of branches/plant donor. Also, it was detected that Balady population had high plant height, fresh, dry and protein forage yields and was located in stability region. Thus, this population could be advised for commercial alfalfa production in Egypt.

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تأثير الصنف وموعد الزراعة علي المحصول العلفي ومكوناته في البرسيم الحجازي

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الملخص

أجري هذا البحث لدراسة تأثير درجات الحرارة الناتجة عن اختلاف مواعيد الزراعة خلال مراحل النمو الخضري وتأثير تفاعل التراكيب الوراثية والنبات (مواعيد الزراعة × مواسم النمو) علي المحصول العلفي ومكوناته في بعض عشائر البرسيم الحجازي. تم زراعة ستة عشائر مصري (أسوان، البلدي، الداخلة، الإسماعيلية-١ ، مثبت نيتروجين ، سيوة) بالإضافة إلي صنف واحد من الولايات المتحدة الأمريكية (جنان) في ثلاثة مواعيد زراعة (٢٠ أكتوبر ، ٢٠ نوفمبر ، ٢٠ ديسمبر) في تصميم القطاعات الكاملة العشوائية (RCBD) باستخدام ثلاث مكررات في كل ميعاد زراعة. وتم أخذ ثلاث حشات علي فترات (٨٠ ، ١٢٥ ، ١٦٥ يوم من الزراعة) ونفذت التجربة خلال موسمي ٢٠١٥/٢٠١٤ ، ٢٠١٦/٢٠١٥ في المزرعة البحثية لكلية الزراعة جامعة جنوب الوادي بمحافظة قنا.

ويمكن تلخيص أهم النتائج فيما يلي:

١- كان لمواعيد الزراعة والأصناف تأثير معنوي لصفة طول النبات ، عدد الفروع/للنبات، نسبة الأوراق/السيقان والمحصول العلي الموسمي الطازج والبروتيني في التحليل المشترك للسنوات.

٢- أعطت عشيرة أسوان أطول النباتات وأعلي محصول علفي لمتوسط مواعيد الزراعة الثلاثة في الموسمين.

٣- تم الحصول علي أطول النباتات وأعلي عدد من الأفرع للنبات وأكبر محصول علفي طازج وجاف وبروتيني من ميعاد الزراعة في ٢٠ ديسمبر لمتوسط الموسمين.

٤- أظهرت البيئات، الأصناف والتفاعل بينها اختلافاً معنوياً لصفة طول النبات ، عدد الأفرع/للنبات والمحصول العلفي الموسمي الطازج والجاف والبروتيني.

وشملت منطقة الثبات عشائر سيوة، البلدي، الداخلة وعشيرة مثبت النيتروجين الأمريكي لصفة طول النبات، وعشائر جنان والإسماعيلية-١ لصفة المحصول العلفي الطازج بينما كانت كل العشائر فيما عدا عشائر الداخلة وأسوان لصفة المحصول العلفي البروتيني.