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RESEARCH ARTICLE

Forage and Seed Yield Variation of Alfalfa Cultivars in Response to Planting Date

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Abstract: The current work was carried out during 2014/15 and 2015/16 seasons at the Experimental Farm of Agriculture Faculty, South Valley University, Qena Governorate, Egypt to study the direct and indirect effects of yield attributes on forage and seed yields of alfalfa. Six alfalfa genotypes from Egypt (Aswan population, Balady population, El-Dakhla population, Ismalia-1 cultivar, and nitrogen fixing population and Siwa population) beside one variety from USA (Genan) were used in this study. The experiments were laid out in randomized complete block design using split plot arrangement with three replications. Three sowing dates of 20th October (D1), 20th November (D2) and 20th December (D3) were allocated in the main plot while the seven alfalfa genotypes were arranged in the sub plots. Three cuts were taken from each sowing date at 80, 125 and 165 days after sowing at 80, 45- and 40-day intervals, respectively. After taking three cuts, the plants were left out until flowering and seed production which take place in the first week of April, May and June for studied sowing dates, respectively. The obtained results show that, the Ismalia-1 cultivar exceeded the other tested genotypes for seasonal fresh forage yield trait (6.16 kg m^{-2}) under third planting date (20th December) while, El-Dakhla genotype superior with regard to seasonal dry forage yield (2.00 kg m^{-2}) under the same planting date. Otherwise, Aswan population produced the maximum mean values of Seasonal protein forage yield (0.60 kg m^{-2}) under second planting date (20th November). In addition, Genan cultivar which was introduced from USA gave the maximum seed yield plant (1.20 g) under the first planting date (20th October). Furthermore, the obtained results show that the fresh forage yield had the greatest influence on protein forage yield in each sowing date. Meantime, the results of path analysis show that, number of seeds/pod and number of pods/plant considered the most effective traits in seed yield/plant of alfalfa. Moreover, negative correlation between seed yield/plant and 1000-seed weight was observed. Therefore, selection for improving seed yield/plant may be carried directly through selection for number of seeds/pod and number of pods/plant.

Key words: Alfalfa, path analysis, sowing dates

INTRODUCTION

Alfalfa or Lucerne (*Medicago sativa* L.) is cultived mainly for forage and seed yields production. The seed yield is considered to be of only secondary importance.

The main objectives of the most alfalfa breeding programs are to be increased forage and seed yields. Since it is not possible to achieve genetic progress over the limits determined by existing genes in a population, the choice of germplasm included in a breeding program is a top priority for every breeder (Popovic *et al.*, 2006). Genetic diversity for seed yield and seed yield

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components in alfalfa was described between and within populations by Bolanos-Aguilar *et al*. (2000). Forage production would benefit from specialization in seed production directed at the consistent, reliable production of heavy yields with high seed quality. According to Rincker *et al*. (1988), successful alfalfa seed production is favored in regions where the growing season is characterized by low relative humidity and moderate to high temperature. Selection of promising genotypes in a breeding program is based on various criteria, most importantly final crop yield and its components. Relationships between yield and yield contributing traits also play an important role (Diz *et al*., 1994). Environmental conditions during seed development, genetic characteristics and agronomic techniques have considerable effect on seed yield and components of yield through their effect on plant reproductive.

Path analysis is used to determine the amount of direct and indirect effects of the causal components on the effect component. As previous studies, plant breeders could find well qualified varieties with certain characteristics by using path analysis at the terminal selection stage of breeding. Suleyman and Meryem (2006) found positive direct effect of number of pods per raceme and number of seed per raceme and seed yield of alfalfa and suggested that these yield components may be good selection criteria to improve seed yield of alfalfa cultivars. In contrast, Kowithayakorn & Hill (1982) and Askarian *et al.* (1995) found that the number of seeds/pod was an unimportant yield component.

The objective of this study was to identify characteristics induced either by environmental or genetic factors that explain forage and seed yields variation in alfalfa, in terms of forage and seed yields and their components, using path-coefficient analysis to determine the relationships of yield components to one another.

MATERIALS AND METHODS

Six genotypes from Egypt (Aswan population, Balady population, El-Dakhla population, Ismailia-1 cultivar, Nitrogen fixing population, Siwa population) beside one variety from U.S.A. (Genan) were used for this study. These materials were cultivated at the Experimental Farm, Faculty of Agriculture, South Valley University, Qena governorate, Egypt, during 2014/2015 and 2015/2016 seasons. The physical and chemical properties of the experimental soil in 2014/2015 and 2015/2016 seasons are sand (82 and 85%), silt (8 and 11%), clay (10 and 4%), soil pH (7.7 and 8) organic matter (0.17 and 0.15%), total N mg/kg (198 and 34) and $CaCO_3$ (8.5 and 9.7%), in the first and second seasons respectively. Climatic data in this location during the study period including maximum and minimum daily temperature and relative humidity, beside photoperiod from sowing date until seed maturity are presented in Table 1.

Experimental design:

The experiments were laid out in randomized complete block design using split plot arrangement with three replications. Three sowing dates of 20th October (D1), 20th November (D2) and 20th December (D3) were allocated in the main plot while the seven alfalfa genotypes were arranged in the sub plots.

Agricultural practices:

The sub plot size was one-meter square (3 meters long x 0.33 m apart). Alfalfa seeds were drilled by hand at the rate of 10.0 g/m^2. Phosphorus was applied at level of 4 grams P_2O_5 15.5%/plot before seeding. All other cultural practices were done as the recommended for alfalfa production. Three cuts were taken from each sowing date at 80, 125 and 165 days after sowing at 80, 45- and 40-day intervals, respectively. After taking three cuts, the plants were left out until flowering and seed production which take place in the first week of April, May and June for studied sowing dates, respectively.

Data recorded

Forage yield

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

1- Seasonal fresh forage yield (kg/m^2): determined by clipping each plot, then total of three cuts were taken for each sowing date. Seasonal dry forage yield (kg/m^2) estimated by using, seasonal fresh forage yield of each plot × mean dry matter percentage, where dry matter percentage was determined from random samples of 150 grams from each plot at each cut, after drying in an oven at 70°C until weight constancy.
2- Seasonal protein forage yield (kg/m^2) estimated by using seasonal dry forage yield/m^2 × protein percentage or seasonal fresh forage yield × mean dry matter percentage × protein percentage. The protein percentage was determined by micro-kjeldahle method as outlined by A.O.A.C. (2000) to estimate the total nitrogen. Nitrogen percentage was multiplied by 6.25 to obtain crude protein.

Seed yield and its attributes

At seed maturity stage, the following traits were determined on a sample of 10 plants randomly collected from the center of each plot and for each sowing date: number of pods $plant^{-1}$, number of seeds pod^{-1}, thousand seed weight (g.), seed yield $plant^{-1}$ (g).

Statistical analysis:

The combined analysis of means for all studied traits were subjected to regular statistical analysis of variance of the randomized complete block design (RCBD)under split plot arrangement according to Gomez and Gomez, (1984). Bartlett test of variance homogeneity was carried out before the combined analysis (Steel *et al.* 1997). Mean comparison were performed using revised least significant difference (R.L.S.D.) at 5% level of probability.

Path coefficient analysis

Path coefficient analysis was done according to the procedure suggested by Dewey and Lu (1959) for forage yield and its components as well as seed yield and its components, as the following:

Forage yield and its components

First order components of protein forage yield in alfalfa (Y) are:

1- Fresh forage yield (f), 2- mean dry matter percentage (m), 3- mean protein percentage (t) and residual factors (x) for each sowing date as shown in Figure 1.

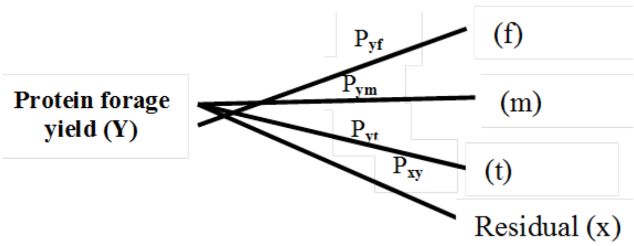

Figure 1. The direct effect and associations of components of protein forage yield and the factors influencing the components.

The correlation coefficients were partitioned into direct and indirect effects as illustrated in the following set of linear equations:

$$r_{yf} = P_{yf} + r_{fm} P_{ym} + r_{ft} P_{yt}$$

$$r_{ym} = P_{ym} + r_{fm} P_{yf} + r_{mt} P_{yt}$$

$$r_{yt} = P_{yt} + r_{ft} P_{yf} + r_{mt} P_{ym}$$

$$1 = P_x^2 + P_{yf}^2 + P_{ym}^2 + P_{yt}^2 + 2P_{yf} r_{fm} P_{mt} + 2P_{yf} r_{ft} P_{mt} + 2P_{ym} r_{mt} P_{yt}$$

Where r is the correlation coefficient between variables, P is the path coefficient measuring the direct effects, and other is the measure of the indirect effects of one variable upon another.

Seed yield and its components.

In the same manor, the diagram could be similar for seed yield and its components. Variables of seed yield/plant which were considered to contribute to seed yield/plant (S) were; 1- number of pods/plant, 2- number of seeds/pod, 3- seed index (1000 seed weight) and (X) residual factors.

The path-coefficients in this particular instance were obtained by the simultaneous solution of the above equations.

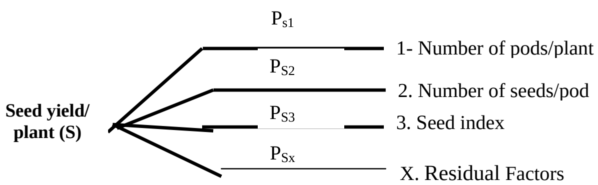

Figure 2.The direct effect and associations of components of seed yield and the factors influencing the components.

$$r_{S1} = P_{S1} + r_{12} P_{S2} + r_{13} P_{S3}$$

$$r_{S2} = P_{S2} + r_{12} P_{S1} + r_{23} P_{S3}$$

$$r_{S3} = P_{S3} + r_{13} P_{S1} + r_{23} P_{S2}$$

Where r is the correlation coefficient between variables, P is the path coefficient measuring the direct effects, and other is the measure of the indirect effects of one variable upon another.

The path-coefficients in this particular instance were obtained by the simultaneous solution of the above equations.

RESULTS AND DISCUSSION

Variability and correlation

The combined analyses of variance for the studied traits over the two seasons are shown in Table 2. Results show that the studied sowing dates, genotypes and their interaction had significant effects on all studied traits except seasonal dry forage yield and 1000-seed weight traits which were insignificant. Furthermore, data recorded in Table 3 reveal that the studied traits varied significantly via tested variables. Thus, seasonal fresh forage and protein forage yields, seed yield and its components show the maximum ranges of variation. Moreover, it is clear from the presented data in the Table 3 that the Ismalia-1 cultivar exceeded the other tested genotypes for seasonal fresh forage yield trait (6.16 kg m^{-2}) under third planting date (20^{th} December) while, El-Dakhla genotype superior with regard to seasonal dry forage yield (2.00 kg m^{-2}) under the same planting date. Otherwise, Aswan population produced the maximum mean values of Seasonal protein forage yield (0.60 kg m^{-2}) under second planting date (20^{th} November). In addition, Genan cultivar which was introduced from USA gave the maximum seed yield plant (1.20 g) under the first planting date (20^{th} October). Ibrahim *et al.* (2015) and Strbanovica *et al.* (2015) reported that the investigated alfalfa genotypes exhibited high total variability in dry matter yield and crude protein. Here too, the phenotypic correlation among protein forage yield traits under the three sowing dates over the two seasons are shown in

Table 4. The coefficient of phenotypic correlation under three sowing dates over two seasons between protein forage yield and each of fresh forage yield, dry matter percentage, and protein percentage were 0.250, 0.363 and 0.283 in the first, sowing date being, 0.862, -0.065 and 0.466 in the second sowing date and 0.935, 0.163 and 0.258 in the third sowing date, respectively. These results indicate that the most effective components in protein forage yield of alfalfa would be fresh forage yield in major issue and dry matter percentage and protein percentage in minor role. The phenotypic correlation among seed yield/plant traits under three sowing dates over two seasons are shown in Table 5. The coefficient of phenotypic correlation under the three sowing dates over the two seasons between seed yield/plant and each of number of pods/plant, number of seeds/pod and seed index were 0.221, 0.873 and -0.351; respectively, in the first sowing date being, 0.454, 0.872 and -0.158, respectively, in the second sowing date over the two seasons. Moreover, correlations over the two seasons under the third sowing dates approximately had the same trend (0.964, 0.758 and -0.490). These results indicate that the most effective components in seed yield/plant of alfalfa would be the number of seeds/pod and the number of pods/plant. However, there was negative correlation between seed yield/plant and 1000-seed weight. These results are in line with those obtained by Sengul (2006**)** who found that seed yield was significantly positively correlated with the number of seeds/ inflorescences (r= 0.593), number of pods/inflorescence (r= 0.602).

Path-coefficient analysis

1- Forage yield and its components

Path-coefficient analysis was used to determine the direct and indirect effects of the fresh forage yield, dry matter percentage and mean protein percentage on protein forage yield under the three sowing dates over the two seasons are presented in Table 4 and Figure 1. Figure (1) is a path diagram showing the direct and indirect influences of protein forage yield components traits for each sowing date. In each sowing date fresh forage yield had the greatest influence on protein forage yield as indicated by phenotypic correlations as well as path-coefficient analysis. The path-coefficient analysis differed from sowing date to another and among seasons. Also, the path-coefficient analysis revealed that fresh forage yield contributed most direct effect for each sowing dates over the two seasons (Table 4) but was negative for indirect via dry matter percentage and protein percentage in each sowing date over the two seasons. This may indicate that the fresh forage yield had the major effects in direct contribution toward protein forage yield. To sum, protein forage yield of forage crops could be generally a function of fresh forage yield × mean dry matter percentage × mean protein percentage. Direct effect of fresh forage yield on protein forage yield over two seasons were 1.654, 0.952 and 0.937 for the first, second and third sowing dates, respectively. However, its indirect effects via mean dry matter percentage were -0.574, -0.082 and -0.037 and via protein percentage were -0.830, -0.008 and 0.035. Mean dry matter percentage had positive direct effect (0.777, 0.172 and 0.351) and negative indirect effect via fresh forage yield (-1.223, -0.452 and -0.097). Moreover, mean protein percentage had a positive direct effect (1.016, 0.391, and 0.255) and a negative and positive indirect effect via fresh forage yield (-1.352, -0.020 and 0.127) and via dry matter percentage

(0.619, 0.095 and -0.125). It could be concluded that the fresh forage yield, dry matter percentage and protein percentage are important traits for selection of high protein forage yield in alfalfa as a results of direct effect in path-coefficient analysis (Table 4). With this respect, Julier *et al*. (2000) stated that forage yield and its quality are complex traits whose expression is influenced by genetic constitution of a plant as well as environmental factors. Because of the above-mentioned reasons, determining the genetic potential of the alfalfa ecotypes and the interrelation among traits are of high importance. Monirifar (2011) reported that plant dry weight had a positive relation with all other yield components. Also, these results are in line with those reported by Bakheit (1988) and Hamd Alla *et al*. (2013) in Egyptian clover who found that seasonal fresh forage yield had the highest positive direct effect on seasonal protein forage yield (0.84) followed by mean dry matter percentage (0.46) and protein percentage (0.172).

On the other hand, the residual effect of path-coefficient for yield trait was negligible in most environments, indicating that there are no other traits not recorded in the research.

2- Seed yield and its components

Path-coefficient analysis was used to determine the direct and indirect effect of number of pods/plant, number of seeds/pod, and seed index (1000-seed weight) on seed yield/plant (Table 5 and Figure 2). Results show that the relative importance of the primary seed yield components was different from sowing date to another. On the other hand, in this study path-coefficient analysis showed complex interrelations among seed yield components because number of pods/plant, number of seeds/pod, and 1000-seed weight were all important in determining seed yield in alfalfa. This means that, seed yield/plant of alfalfa could be generally a function of number of pods/plant x number of seeds/pod x 1000-seed weight over the two seasons. Direct effects of number of pod/plant on seed yield/plant were 0.511, 0.390 and 0.823 in the first, second and third sowing dates, respectively. While, indirect effects via seed index were; -0.233, -0.047 and -0.070 in the same order. While, the direct effect of number of seed/pod on seed yield/plant were 1.186, 0.997 and 0.359, respectively, but the indirect effect via seed index were -0.288, -0.168 and -0.086 at the same order. Also, the direct effect of 1000-seed weight on seed yield/plant were 0.526, 0.359 and 0.141, respectively, but the indirect effect via number of seeds/pod were -0.650, -0.466 and -0.219. With this respect very little information was available on alfalfa seed yield associations with inflorescences level. A large genetic variation among and within population of alfalfa for seed yield and its component was reported by Campbeil & He (1997). The seed yield components responded differently to the effect of plant genetics and management techniques (Sengul, 2006). Iannucci *et al*. (2002) reported complex interactions among seed yield components with inflorescence density, pods/inflorescence, seed/pod and 1000-seed weight. These results are in line with those reported by Sengul (2006).

Table 1: Summary of some meteorological data during the period of alfalfa growth in 2014/2015 and 2015/2016 seasons.

Month	Weather factor	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	72.30	29.60	49.60	71.86	23.30	47.58	5:54	17:09	11:14	5:54	17:09	11:14
	11-20	25.58	12.00	18.79	21.93	9.12	15.53	71.20	28.20	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	66.90	27.10	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	68.00	25.30	44.40	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	18.30	22.54	8.43	15.49	51.30	16.90	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	53.70	13.70	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	59.30	15.10	37.30	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	36.40	9.70	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	36.40	9.70	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	40.90	24.85	32.875	43.74	27.94	35.00	28.70	7.00	17.50	22.92	5.34	14.13	6:06	17:00	10:54	6:06	17:00	10:54
	11-20	39.62	24.98	32.30	42.41	26.28	34.27	35.50	7.50	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	36.10	9.10	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	39.50	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	37.20	9.90	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

Table 2: **Combined analysis of variance for forage and seed yields and its components of seven alfalfa genotypes under three different sowing dates over the two seasons.**

Source of variation	Degrees of freedom	Mean Squares						
		Forage traits			Seed traits			
		Seasonal fresh forage yield (kg/m^2)	Seasonal dry forage yield (kg / m^2)	Seasonal protein forage yield (kg/m^2)	Number of pods/plant	Number of seeds/pod	1000 seed weight (g)	Seed yield/ plant (g)
Year (Y)	1	40.05**	7.72**	0.46**	1594.5**	49.87**	1.64**	1.19**
Error (a)	4	0.99	0.02	0.003	57.32	0.31	0.01	0.03
Sowing date (D)	2	15.79**	0.79	0.08**	600.92**	29.85**	9.4**	0.27**
Y x D	2	0.49	0.20	0.01	700.45**	7.61**	1.57**	0.06
Error (b)	8	1.30	0.89	0.06	58.43	0.92	0.05	0.04
Genotypes (G)	6	15.30**	1.03*	0.09**	475.65**	8.65**	0.33**	0.27**
G x Y	6	3.09**	0.16	0.008	442.25**	0.91	0.23**	0.11**
G x D	12	1.52**	0.15	0.03**	755.8**	4.11**	0.04	0.19**
G x D x Y	12	1.77**	0.22**	0.01	223**	5.01**	0.51**	0.09**
Error (c)	72	0.43	0.10	0.007	67.11	0.84	0.03	0.03

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

Table 3: Means of the studied traits over the two seasons for the seven alfalfa genotypes under the three sowing dates.

Sowing dates	Traits / Genotypes	Seasonal fresh forage yield (kg/m^2)	Seasonal dry forage yield (kg / m^2)	Seasonal protein forage yield (kg/m^2)	Number of pods/plant	Number of seeds/pod	1000 seed weight(g)	Seed yield/ plant (g)
	Aswan	5.05	1.64	0.37	54.6	4.20	2.82	0.54
	Balady	4.50	1.52	0.32	59.4	6.35	2.70	0.96
	El-Dakhla	4.43	1.59	0.34	56.2	5.28	2.53	0.83
D_1	Ismalia-1 cultivar	4.86	1.35	0.25	69.2	4.67	2.61	0.75
	Nitrogen fixing	4.30	1.52	0.31	70.4	4.65	2.55	0.75
	Genan	2.86	1.26	0.29	64.1	6.57	2.39	1.20
	Siwa	4.25	1.44	0.34	62.4	6.63	2.51	0.97
	Aswan	5.75	1.96	0.60	58.5	3.49	2.97	0.67
	Balady	4.80	1.43	0.31	62.6	5.12	2.90	1.01
	El-Dakhla	5.71	1.78	0.51	56.3	5.89	2.53	0.74
D_2	Ismalia-1 cultivar	3.74	1.35	0.35	67.8	4.08	2.74	0.83
	Nitrogen fixing	3.24	1.16	0.30	67.9	4.37	2.62	0.77
	Genan	2.28	1.07	0.24	69.5	6.53	2.68	0.92
	Siwa	3.71	1.23	0.30	64.0	5.08	2.94	0.94
	Aswan	5.69	1.94	0.47	45.5	6.06	2.07	0.58
	Balady	5.79	1.71	0.40	50.3	6.71	2.00	0.69
	El-Dakhla	5.92	2.00	0.44	81.0	8.18	1.66	1.11
D_3	Ismalia-1 cultivar	6.16	1.76	0.46	54.5	6.43	1.88	0.69
	Nitrogen fixing	5.68	1.72	0.40	45.7	6.90	1.82	0.58
	Genan	3.40	1.08	0.25	40.9	5.71	1.81	0.44
	Siwa	5.01	1.58	0.39	78.0	6.14	1.88	0.89
R L.S.D. (D*G)		0.77	-	0.131	8.7	1.05	-	0.19

Table 4: Path coefficient analysis of protein forage yield and its components over the two seasons for the three planting dates.

Effect	Combined over years		
	Date 1	**Date 2**	**Date 3**
Correlation between protein forage yield and fresh forage yield	**0.250**	**0.862**	**0.935**
Direct effect of fresh forage yield on protein forage yield	1.654	0.952	0.937
Indirect Effect of fresh forage yield on protein forage yield via dry matter %	-0.574	-0.082	-0.037
Indirect effect of fresh forage yield on protein forage yield via protein %	-0.830	-0.008	0.035
Total indirect effect	-1.404	-0.090	-0.002
Correlation between protein forage yield and dry matter %	**0.363**	**-0.065**	**0.163**
Direct effect of dry matter %on protein forage yield	0.777	0.172	0.351
Indirect effect of dry matter % on protein forage yield via fresh forage yield	-1.223	-0.452	-0.097
Indirect effect of dry matter % on protein forage yield via protein %	0.810	0.215	-0.091
Total indirect effect of dry matter %	-0.413	-0.237	-0.188
Correlation between protein forage yield and protein %	**0.283**	**0.466**	**0.258**
Direct effect of protein % on protein forage yield	1.016	0.391	0.255
Indirect effect of protein % on protein forage yield via fresh forage yield	-1.352	-0.020	0.127
Indirect effect of protein % on protein forage yield via dry matter %	0.619	0.095	-0.125
Total indirect effect of protein %	-0.733	0.075	0.002
Residual effect	**0.008**	**0.004**	**0.001**

Table 5: **Path coefficient analysis of seed yield per plant and its components over the two seasons for the three planting dates.**

Effect	**Combined over years**		
	Date 1	**Date 2**	**Date 3**
Correlation between number of pods per plant and seed yield per plant	**0.221**	**0.454**	**0.964**
Direct effect of number of pods per plant on seed yield per plant	0.511	0.390	0.823
Indirect effect of number of pods per plant on seed yield via seed index	-0.233	-0.047	-0.070
Indirect effect of number of pods per plant on seed per plant via no. of seeds per pod	-0.056	0.111	0.211
Total indirect effect of number of pods per plant	-0.289	0.065	0.141
Correlation between seed index and seed yield per plant	**-0.351**	**-0.158**	**-0.490**
Direct effect of seed index on seed yield per plant	0.526	0.359	0.141
Indirect effect of seed index on seed yield per plant via no. of seed per pod	-0.650	-0.466	-0.219
Indirect effect of seed index on seed per plant via no. of pods per plant	-0.226	-0.051	-0.412
Total indirect effect of seed index	-0.877	-0.517	-0.631
Correlation between no. of seeds per pod and seed yield per plant	**0.873**	**0.872**	**0.758**
Direct effect of no of seeds per pod on seed yield per plant	1.186	0.997	0.359
Indirect effect of no. of seeds per pod on seed yield per plant via no. of pods per plant	-0.024	0.044	0.485
Indirect effect of no. of seeds per pod on seed yield per plant via seed index	-0.288	-0.168	-0.086
Total indirect effect of no. of seeds per plant	-0.313	-0.124	0.399
Residual effect	**0.018**	**0.005**	**0.002**

CONCLUSION

From the obtained results in this study, there are several genotypes had superior potential for seasonal fresh forage yield, seasonal dry forage yield, Seasonal protein forage yield and seed yield plan traits under different planting dates. Thus, the Ismalia-1 cultivar exceeded the other tested genotypes for seasonal fresh forage yield trait (6.16 kg m^{-2}) under third planting date (20th December) while, El-Dakhla genotype superior with regard to seasonal dry forage yield (2.00 kg m^{-2}) under the same planting date. Otherwise, Aswan population produced the maximum mean values of Seasonal protein forage yield (0.60 kg m^{-2}) under second planting date (20th November). In addition, Genan cultivar which was introduced from USA gave the maximum seed yield plant (1.20 g) under the first planting date (20th October). In addition, the results of the path-coefficient analysis suggest that selection for improving seed yield/plant may be carried directly through selection for number of seeds/pod and number of pods/plant.

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