J. Plant Production, Mansoura Univ., Vol. 7(11):1239 - 1244 , 2016

Yield Productivity and Stability of some Varieties of Egyptian Clover

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ABSTRACT

The present investigation was carried out to study the productivity of fresh and dry forage yield and stability parameters of five varieties of Egyptian clover (*Trifolium alexandrinum* L.). Five varieties (Helaly, Sakha 4, Giza 6, Gemmiza 1 and Serw1) were sown on three sowing dates (1st October, 15th October and 1st November) in a split plot design. The experiment was conducted at two experimental stations, Sids and Giza during 2011/2012 and 2012/2013 seasons. Five cuts were taken from the first and second dates of sowing wile only four cuts were taken from the third sowing date. Results revealed that mean squares of varieties, dates of sowing, varieties x dates and varieties x locations were highly significant for total fresh and dry forage yields. As an average performance of all varieties, total fresh and dry forage yields were higher at Sids compared to Giza. The highest fresh and dry forage yields of varieties were obtained from the first and second dates of sowing at the two locations while the lowest fresh and dry forage yields for varieties were obtained from the third sowing date. As an average sowing dates, Helaly variety out yielded of fresh (54.83 fad^{-1}) and dry (8.17t fad^{-1}) yields other tested varieties. The estimates of phenotypic stability parameters (bi and s^2di) for fresh yield showed that the highest yield variety Helaly exhibited less instability while the variety Gemmiza 1 was more stable. The estimates of phenotypic stability parameters (bi and s^2di) for dry yield showed that the highest yield and stable variety was Helaly. Therefore, these varieties Gemmiza 1 and Helaly could be recommended as good source in breeding programs.

Keywords: Egyptian clover, *Trifolium alexandrinum*,. Fresh forage yield, Dry forage yield, Sowing date, Phenotypic stability parameters.

INTRODUCTION

Egyptian clover (*Trifolium alexandrinum*, L.) is the most important winter forage crop in Egypt. Egyptian clover is high nutritional quality for animal feed. Egyptian clover also contributes to soil-fertility and improved soil physical characteristics (Graves *et al.*, 1996).

Genotype-environment interaction is one of the major concerns for plant breeder in generating and developing improved varieties. Several authors have studied the causes of observed interactions between genotypes and environments (GE). The early attempt focused on the importance of GE interactions in plant breeding based on regression analysis (Yates and Cochran 1938) to measure the adaptation of barley varieties. They proposed that when genotypes were tested in several environments, the yield of each genotype should be regressed on the mean yield of all genotypes in each environment. Finlay and Wilkinson (1963) proposed average yield of all varieties for each site and season, as a measure of that environment "environmental value". They considered the regression coefficient (b_i) of mean for each genotype yield performance on the mean yield of all genotypes for each site and season, as a measure of adaptability. Eberhart and Russell (1966) suggested the use of "environmental index" for each environment, as the deviation of mean performance from the grand mean of all environments. They pointed out that both of the regression coefficient (b_i) and the deviation from regression of a variety on the environmental indices (S^2d_i) are considered as parameters for response and stability of variety, respectively. So, stability in yielding ability is one of the most desirable properties of a variety to be released for economic large scale cultivation. For this purpose the multi locations trials over a number of years should be conducted (Tehlan, 1973 and Luthra et al. 1974).

Current change in the climatic conditions towards warming especially in Egypt are expected to prolong the summer season and shorten the winter season during which Egyptian clover is grown. Thus, it was thought desirable to change the sowing date of Egyptian clover to avoid the high temperature effects at the beginning of the fall season; a practice which was studied by few workers.

The objective of the present study was to evaluate the yield response adaptation and stability of five varieties of Egyptian clover (*Trifolium alexandrinum*, L.) at different dates of sowing and locations in Egypt.

MATERIALS AND METHODS

This study was carried out at two experimental stations, Sids and Giza during 2011/2012 and 2012/2013 seasons to evaluate the yield response adaptation and stability of five varieties of Egyptian clover (*Trifolium alexandrinum*, L.) under different dates of sowing. Treatments involved three sowing dates (1st of October, 15th of October and 1st of November) and five Egyptian clover varieties .

A split plot design with three replicates was used in both seasons. Sowing dates occupied the main plots and Egyptian varieties (1- Helaly, 2- Sakha 4, 3- Giza 6, 4- Gemmiza 1 and 5- Serw 1) were placed in the subplots. Sub-plots size was 10.5 m^2 with 15 rows 3.5m^2 long, 20 cm apart. Egyptian clover seeds were sown by hand at the rate of 20 kg fad^{-1}. All cultural practices were maintained at optimum level for maximum Egyptian clover productivity. Five cuts were taken from the first and second dates of sowing at 65, 105, 140, 170, 190 days from sowing, respectively.

Only four cuts were taken from third sowing date at 75, 115, 150, 180 day from sowing, respectively.

Data of fresh and dry forage yields of the cuts and total yield were recorded in kg/plot for all cuts, then transformed to ton/fad. Combined analysis for the five varieties for total fresh and dry forage yield was executed. Also, a combined analysis of variance over seasons and locations for the five varieties under study was carried out for total fresh and dry yields. The procedures of this analysis of variance were performed as outlined by Gomez and Gomez (1984) whenever the homogeneity of variances between seasons was detected. Means were compared using LSD test at 5% level.

Stability analysis was carried out and the phenotypic stability parameters; regression coefficients (b_i) and mean square deviations from regression (S^2d_i) were computed for each variety using the model described by Eberhart and Russell (1966). This model provides the means of portioning the genotype-environment interaction of each variety into two parts: (1) the variation due to the response of variety to varying environmental indexes (b_i) and (2) the unexplainable deviations from the regression on the environmental index (S^2d_i). Based on this model the desired variety would have a high mean, a regression coefficient (b_i =1) and a deviation from regression as small as possible (S^2d_i=0). Hence, the definition of a stable variety will be one with b_i =1 and S^2d_i=0.

RESULTS AND DISCUSSION

Performance of the varieties:

Combined analyses of variance of the studied traits are presented in Table (1). The results revealed highly significant differences between planting dates and among varieties for both fresh and dry forage yields. The interaction between varieties, locations and planting dates were also highly significant for both traits. The presence of these interactions suggested a differential response of varieties to varied planting dates and locations. Similar results were obtained by El-Zanaty (2005).

Table 1. Mean squares from ANOVA for total fresh and dry forage yields of Egyptian clover over seasons and locations.

Source of variance	d.f.	Mean squares for forage yield	
		Fresh	Dry
Years (Y)	1	1.393	0.328
Locations (L)	1	1684.4	28.857
Error 1	1	212.9	0.669
Rep. (R)	2	17.194	0.255
L x R	2	23.134	0.553
Error 2	4	23.689	0.554
Date (D)	2	3745.3**	41.205**
L x D	2	11.162	1.060
R x D	4	9.926	0.198
R x L x D	4	1.685	0.043
Error 3	12	6.726	0.339
Varieties (V)	4	154.592**	4.054**
L x V	4	61.942**	1.538**
R x V	8	8.521	0.123
R x L x V	8	20.898*	0.496*
D x V	8	34.685**	1.407**
Lx D x V	8	8.442	0.273
R x D x V	16	4.054	0.180
R x L x D x V	16	2.852	0.083
Error4	72	9.232	0.205

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

Performance of the varieties for total fresh forage yield under different dates of sowing at the two locations over the two seasons are presented in Table (2). Data over the two seasons for total fresh forage yield showed significant differences among the five varieties under different dates of sowing at the two locations. The average performance of the five varieties for total fresh yield at Sids (55.73 t fad^{-1})was higher than that of Giza (49.61 t fad^{-1}). Over three dates, performance of the five varieties for total fresh yield at Sids ranged from 54.50 to 57.37 t fad^{-1} and at Giza ranged from 44.07 to 52.28 t fad^{-1}. The average performance of the five varieties for total fresh yield at 1st sowing date (64.26 and 58.51 t fad^{-1}) was higher than the other two dates of sowing at sids and Giza, respectively. The average performance of the five varieties for total fresh yield at the third sowing date was the lowest one (48.73 and 43.23 t fad^{-1}) at Sids and Giza, respectively. Fresh yield of the third sowing date at the two locations was low because of four cuts only were obtained while five cuts were obtained from the other two dates. Total fresh forage yield of five varieties at the first sowing date at Sids ranged from 63.30 to 66.80 t fad^{-1} with an average of 64.26 t $fad^{-1}$and at Giza ranged from 52.18 to 62.11 t fad^{-1} with an average of 58.51 t fad^{-1}.Total fresh forage yield of the five varieties

at the second sowing date at Sids ranged from 50.96 to 58.24 t fad^{-1} with an average of 54.19 t fad^{-1} and at Giza ranged from 41.15 to 50.54 t fad^{-1}with an average of 47.89 t fad^{-1}. Total fresh forage yield of the five varieties at the third sowing date at Sids ranged from 40.73 to 49.62 t fad^{-1} with an average of 40.73 t fad^{-1}and at Giza ranged from 44.07 to 52.28 t fad^{-1} with an average of 43.23 t fad^{-1}.

Table 2. Varietal variation for total fresh forage yield (t fad^{-1}) of Egyptian clover under different dates of sowing at two locations over two seasons.

Genotype	Sids				Giza			
	1st date	2nd date	3rd date	Mean	1st date	2nd date	3rd date	Mean
Helaly	65.10	58.24	48.77	57.37	61.44	50.54	44.87	52.28
Sakha4	62.17	57.38	49.62	56.39	58.03	48.89	44.67	50.26
Giza-6	66.80	52.00	46.60	55.13	62.11	48.83	44.36	51.77
Gemmiza 1	63.97	52.38	49.43	55.26	58.79	46.84	43.38	46.67
Serw 1	63.30	50.96	49.24	54.50	52.18	41.15	38.88	44.07
Mean	64.26	54.19	48.73	55.73	58.51	47.89	43.23	49.61
LSD at 0.05%	2.78	3.28	1.80	1.63	3.45	3.15	2.41	1.62

At the first sowing date the varieties Giza 6 and Helaly were superior in producing the highest yield at Sids 66.80 and 65.10 t fad^{-1} and at Giza 62.11 and 61.44 t fad^{-1}, respectively and exceeded the average of the five varieties. On the other hand, the lowest yield 63.30 and 52.18 t fad^{-1}was obtained from the variety Serw1 at Sids and Giza, respectively. At the second sowing date the varieties Helaly and Sakha 4 were among the top rank, which gave the highest yield at Sids 58.24 and 57.38 t fad^{-1}and at Giza 50.54 and 48.89 t fad^{-1}, respectively and exceeded the average of the five varieties. On the other hand, the lowest yield 50.96 and 41.15 t fad^{-1}was obtained from the variety Serw1 at Sids and Giza, respectively. Fresh yield of four varieties (Sakha 4, Gemmiza 1, Helaly and Serw1) at Sids and (Helaly, Sakha4, Giza6 and Gemmiza1) did not show significant differences, gave the highest yield at the third dates and exceeded the average of all five varieties. On the other hand, the lowest yield 46.60 was obtained from the variety Giza 6 at Sids and 38.88 was obtained from the variety Serw1 at Giza.

Over the two seasons and the three dates at Sids, data indicated that there were no significant differences between yields of the two superior varieties Helaly and Sakha4. While at Giza, the yields of the three varieties Helaly, Giza-6 and Sakha4 were the highest and were not significant. On the other hand the lowest yield was obtained from the variety Serw1 at Sids and Giza.

Performance of the varieties for total dry forage yield under different dates of sowing at the two locations over the two seasons are presented in Table (3). Data over the two seasons for total dry forage yield showed significant differences among the five varieties under different dates of sowing at the two locations. The average performance of the five varieties for total dry yield at Sids (8.17 t fad^{-1}) was higher than that at Giza (7.37 t fad^{-1}). Over the three dates, performance of the five varieties for total dry yield at Sids ranged from 7.99 to 8.47 t fad^{-1} and at Giza ranged from 6.51 to 7.86 t fad^{-1}. The average performance of the five varieties for total dry yield at the 1st sowing date was higher than that of the other two dates of sowing at sids and Giza, respectively. The average performance of the five varieties for total dry yield at the third sowing date was the lowest one (7.35 and 6.60 t fad^{-1}) at Sids and Giza, respectively. Dry yield of the third sowing date at the two locations was low because of four cuts only were taken while five cuts were taken from the other two dates. Total dry forage yield of five varieties at the first sowing date at Sids ranged from 8.76 to 9.38 t fad^{-1} with an average of 8.91 t fad^{-1}and at Giza ranged from 7.18 to 8.91 t fad^{-1} with an average of 8.34 t fad^{-1}.Total dry forage yield of the five varieties at the second sowing date at Sids ranged from 7.76 to 8.94 t fad^{-1} with an average of 8.25 t fad^{-1} and at Giza ranged from 6.34 to 7.73 t fad^{-1}with an average of 7.16 t fad^{-1}. Total dry forage yield of the five varieties at the third sowing date at Sids ranged from 6.92 to 7.55 t fad^{-1} with an average of 7.35 t fad^{-1} and at Giza ranged from 6.00 to 6.95 t fad^{-1} with an average of 6.60 t fad^{-1}.

Table 3. Varietal variation for total dry forage yield (t fad^{-1}) of Egyptian clover under different dates in two locations over two seasons.

Genotype	Sids				Giza			
	1st date	2nd date	3rd date	Mean	1st date	2nd date	3rd date	Mean
Helaly	9.03	8.90	7.49	8.47	8.91	7.73	6.95	7.86
Sakha4	8.50	8.94	7.55	8.33	8.11	7.46	6.86	7.48
Giza-6	9.38	7.76	6.92	8.02	8.89	7.29	6.62	7.60
Gemmiza 1	8.89	7.81	7.39	8.03	8.63	6.99	6.58	7.40
Serw 1	8.76	7.83	7.39	7.99	7.18	6.34	6.00	6.51
Mean	8.91	8.25	7.35	8.17	8.34	7.16	6.60	7.37
LSD at 0.05%	0.52	0.56	0.26	0.27	0.51	0.44	0.33	0.24

At the first sowing date the varieties Giza 6 and Helaly were superior in producing the highest yield at Sids 9.38 and 9.03 t fad^{-1}and at Giza 8.89 and 8.91 t fad^{-1}, respectively and exceeded the average of all five

varieties. On the other hand, the lowest yield 7.18 t $fad^{-1}$was obtained from the variety Serw1 at Giza. At the second sowing date the varieties Helaly and Sakha 4 were among the top rank, which gave the highest yield at Sids 8.90 and 8.94 t fad^{-1} and at Giza 7.73 and 7.46 t fad^{-1}, respectively and exceeded the average of all five varieties. On the other hand, the lowest yield 6.34 was obtained from the variety Serw1 at Giza. Dry yield of the following four varieties (Sakha 4, Gemmiza 1, Helaly and Serw1) at Sids and (Helaly, Sakha4, Giza6 and Gemmiza1) did not show significant differences and gave the highest yield at the third dates and exceeded the average of all five varieties. On the other hand, the lowest yield 6.92 was obtained from the variety Giza 6 at Sids and 6.51 was obtained from the variety Serw1 at Giza.

Over the two seasons and the three sowing dates at Sids, data indicated that there were no significant differences between yields of the two superior varieties Helaly and Sakha4. While at Giza, the yield of variety Helaly was higher. On the other hand the lowest yield was obtained from the variety Serw1 at Sids and Giza.

Stability analysis:

The analysis of variance for the stability of fresh and dry forage yields for the five varieties under twelve environments (2 seasons x 2 locations x 3 dates of sowing) according to Eberhart and Russell (1966) is given in Table (4). As shown, mean squares due to varieties and environments were highly significant for both traits. This reveals that there is variability among varieties as well as among environments under study. Significant mean squares due to environment plus varieties x environment interaction reveal that the varieties interacted considerably with the environmental conditions. In addition, mean square of the pooled deviation was highly significant for both total fresh and dry forage yields. The results of this study are in broad agreement with earlier findings indicating that linear regression forms a predominant portion of genotype x environment interaction in Egyptian (Bakheit, 1985 and Bakheit and El-Hinnawy,1993). Consequently, stability performance should be carried out to identify the reaction and response of each genotype to environment changes.

Table 4. Analysis of variance for total fresh and dry forage yields of Egyptian clover varieties when stability parameters are estimated.

Source of variance	d.f.	Mean squares for forage yield	
		Fresh	Dry
Total (vxEnv-1)	59	62.6882	0.9169
Varieties(v-1)	4	51.5234**	1.3520**
ENV.+(VAR.*ENV.) (V(Env-1))	55	63.5002**	0.8852**
ENVIRONMENT(linear)	1	3142.1875**	38.8069**
VAR.*ENV.(Linear) (V-1)	4	6.3207	0.1689
POOLED DEVIATION (V(Env-2))	50	6.5010**	0.1842**
Helaly	10	6.2050*	0.1023
Sakha4	10	5.0987	0.2181**
Giza-6	10	7.0079*	0.2393**
Gemmiza 1	10	2.4788	0.1133
Serw 1	10	11.7134**	0.2479**
POOLED ERROR (Env.(R-1)(V-1))	96	2.9186	0.0716

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

The phenotypic stability statistics; regression (b_i) and deviation from regression (s^2d_1) for the five varieties in twelve environments are given in Table (5) and Fig. (1). Regarding total fresh forage yield, the three varieties of Helaly, Sakha 4 and Giza 6 performed better than the average performance. These varieties could be of some use for the breeders because the varieties with below average performances are of little practical utility even if they are stable. Regression coefficient (b_i) was significant for all varieties. All varieties except Sakha4 possessed b_i value equal to one. Therefore, the above varieties except Sakha4 were of an average responsive to change in various environments and could perform well under average environmental conditions. All varieties showed significant trend for non-linearity except Sakha 4 and Gemmiza 1. Because value of S^2d_i was not equal zero for all varieties except Gemmiza 1, according to Eberhart and Russell (1966), Gemmiza 1 was more stable than the others for this trait under the all environments conditions studied. Tai (1971) reported that high yielding ability genotypes are unstable over environments and genotypes possessing average stability were generally low in productivity. Results obtained in the present investigation clearly agree with these conclusions.

Concerning total dry forage yield, the same three varieties of Helaly, Sakha 4 and Giza 6 performed better than the average performance. Similar results were obtained for dry forage yield whereas, regression coefficient ($\mathbf{b_i}$) was significant for all varieties. Also, all varieties except Sakha4 possessed $\mathbf{b_i}$ value equal to one. Therefore, the above varieties except Sakha4 were of an average responsive to change in various environments and could perform well under average environmental conditions. All varieties showed significant trend for non-linearity except Helaly and Gemmiza 1. According to the report of Eberhart and Russell (1966), Helaly was more stable than the others for this trait under the all environments conditions studied.

Table 5. Average performance over environments (x) and stability parameters (b_i and S^2d_i) of five Egyptian varieties for total fresh and dry forage yields.

Varieties	Fresh forage yield			Dry forage yield		
	$\bar{X}$	b_i	S^2d_i	$\bar{X}$	b_i	S^2d_i
Helaly	54.8300	0.9953**	4.2867*	8.1714	1.0119**	0.0543
Sakha4	53.3317	0.8495**	3.1804	7.9083	0.7831**	0.1701**
Giza-6	53.4542	1.1278**	5.0895*	7.8136	1.1992**	0.1914**
Gemmiza 1	52.4672	0.9932**	0.5605	7.7181	0.9937**	0.0654
Serw 1	49.2914	1.0342**	9.7950**	7.2544	1.0121**	0.1999**
Means	52.6748	1.0000		7.7731	1.0000	
Slandered error	1.403566	0.1856		0.2362	0.2812	

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

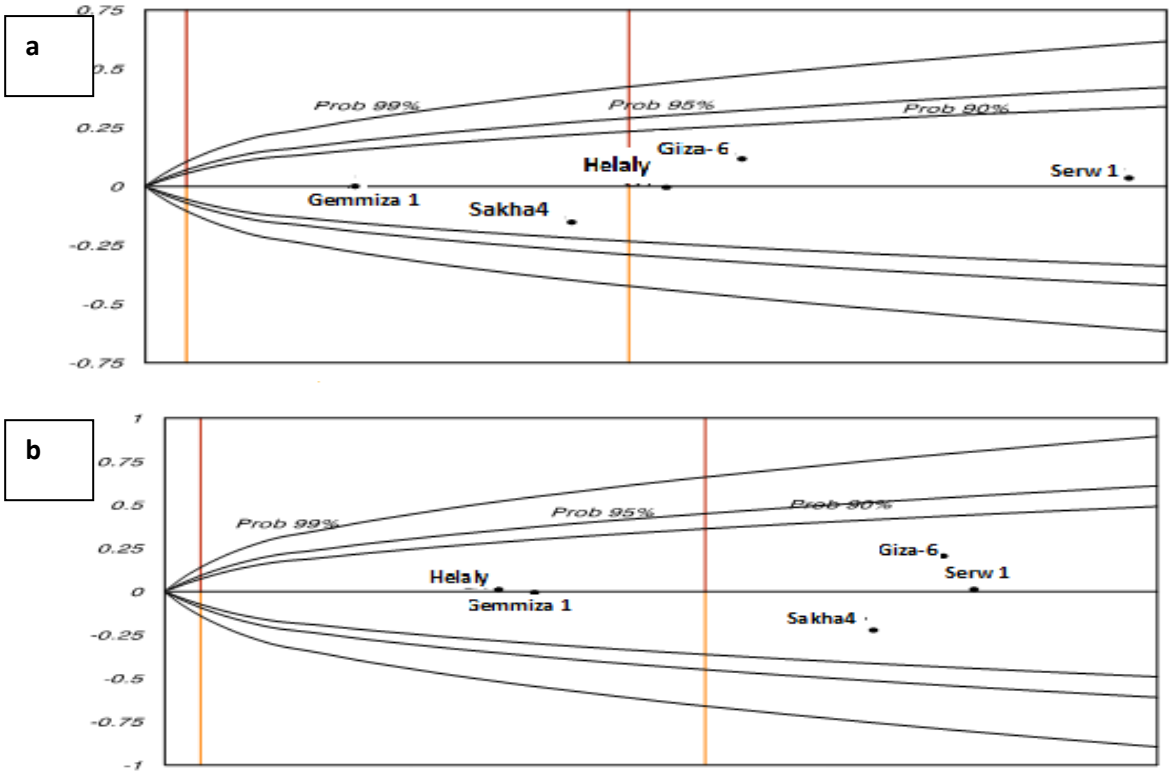

Figure 1. Distribution of genotypic stability statistics of five Egyptian varieties for (a) total fresh and (b) total dry yields (t fad^{-1}).

On the basis of all the investigated parameters, it is quite clear that the variety Gemmiza 1 for total fresh yield and Helaly for total dry yield which had high yield and good response to the changes in environmental conditions and better stability. Therefore, the Gemmiza 1 and Helaly varieties could be grown for high yield and better stability of forage production under different environmental conditions. Moreover, these varieties could be recommended as good source in breeding programs.

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الانتاجية و الثبات المحصولى لبعض اصناف البرسيم المصرى

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اجري هذا البحث بهدف دراسة الانتاجية والثبات المحصولي (العلف الاخضر و الجاف) لخمسة اصناف من البرسيم المصري – تم زراعه الاصناف الخمسة هلالي ، سخا ٤ ، جيزه ٦ ، جميزة ١ ، سرو ١ في ثلاثة مواعيد زراعه وهي اول اكتوبر ، منتصف اكتوبر ، اول نوفمبر بتصميم قطع منشقة مرة واحدة واجريت التجربة في محطتي بحوث الجيزة و سدس اثناء الموسمين ٢٠١١\٢٠١٢ ، ٢٠١٢/٢٠١٣. تم اخذ خمسة حشات من الميعادين الاول و الثاني بينما اخذ اربعة حشات فقط من الميعاد الثالث – اوضحت النتائج ان التباين الراجع الي تأثير الاصناف ومواعيد الزراعه وكذلك التفاعل بين الاصناف مع مواعيد الزراعه و المواقع عالي المعنوية لحاصل العلف الاخضر والجاف الكلي . تفوق حاصل العلف الاخضر والجاف الكلي كمتوسط عام لجميع الاصناف بمحطة بحوث سدس عن الجيزة – بالنسبة لحاصل العلف الاخضر والجاف للاصناف كان اعلي في الميعادين الاول والثاني و اقل في الميعاد الثالث –تفوق الصنف هلالي عن باقي الاصناف في حاصل العلف الاخضر (٥٤.٨٣ طن/فدان) والجاف (٨.٧١ طن/فدان) كمتوسط عام لمواعيد الزراعه الثلاثة - بتقدير ثوابت الثبات المظهري (معامل الانحدار - الانحراف عن خط الانحدار) لحاصل العلف الاخضر تبين ان الصنف هلالي كان اعلي في كمية الحاصل ولكن اقل ثباتا و كان الصنف جميزة ١ هو الاكثر ثباتا - اما بالنسبة لحاصل العلف الجاف تبين ان الصنف هلالي هو الاعلي في الحاصل والاكثر ثباتا ومن ثم يكون الصنفين جميزة ١ ، هلالي مصادر وراثية جيدة يوصي باستخدامها في برامج التربية .