JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2013, 19(4), 413-418

Journal of
Agroalimentary Processes and
Technologies

Evaluate of some varieties of alfalfa for forage yield and its components under the New Valley conditions

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Received: 15 Novemver 2013; Accepted: 14 December 2013

Abstract

The present study was carried out to evaluate six varieties of alfalfa for forage yield and yield components during two successive growing seasons under the conditions of the New Valley arid. The results obtained could be summarized as follows: It is clear result that significant differences were found among varieties for studied traits such as plant height, number of tillers/m^2, leaf/plant ratio, seasonal fresh and dry forage yield in both seasons. The general mean of the studied traits was higher in second year than the first one. Moreover, the combined analysis showed highly significant differences between the two years, varieties and year x var. interaction for traits studied. The great variation was recorded with the obtained values of P.C.V. and G.C.V. for studied traits except leaf/plant ratio and interpreted the significant differences and means possessed with studied genotypes. The all values of correlation coefficient were highly significant, positive and recorded more than 95%. Strongly positive direct and indirect effects were reported for number of tillers/m^2 on seasonal fresh forage yield/plant. This direct effect was 0.9702 and the indirect effects through plant height and leaf/plant ratio were 0.9429 and 0.9446, respectively. So, this trait revealed to be important for selection to forage yield in Alfalfa.

Keywords: Alfalfa, Forage yield, correlation coefficient, Path coefficient analysis

1. Introduction

Alfalfa (*Medicago sativa* L.) is one of the most important forage crops all over the world. Alfalfa produces high quality forage for all classes of livestock and alone can provide energy, protein, minerals and vitamin requirements for dairy cattle. Genetic variability in alfalfa promoted its adaptability for conditions of extreme heat, cold, drought, salinity and pests. This flexibility and high productivity under both stress and optimum conditions are reasons that alfalfa is so widely known as "the queen of forages".

In Egypt, there is a gap between production and demand of green forages, especially during the summer where the available forages are limited as a result of the competition from strategic crops on limited arable land. Alfalfa is nominated to be the best crop to overcome this problem as it is the most suitable forage crop to be cultivated in the newly reclaimed land for producing high yields of high quality forage and longevity of stand.

Mousa et al. (1996) [19] evaluated six alfalfa varieties and found significant differences for plant height, number of tillers/plant, leaf/stem ratio, total fresh and dry forage yields with individual cuttings in the first, second years and combined analyses. Also, all studied traits were significantly affected by seasonal growth in both years. Oushy et al. (1999) [21] studied the seasonal variation in performance of alfalfa genotypes under sandy soil condition.

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The leaf/ stem ratio was significantly different among alfalfa cultivars. In addition to, all tested cultivars have shown remarkable downward trend in leaf/plant ratio from the first to the second year as well as between the same seasons in the two years. Abdel-Galil et al. (2000) [5] studied the productivity of dry yield for five alfalfa cultivars from Egypt and two varieties from U.S.A. at Ismailia and New Valley locations.The productivity of alfalfa was significantly different between and within seasons in Ismailia location and vice versa in the New Valley location. In alfalfa, the variability among and within cultivars is very important for seed yield and all components Bolanos-Aguilar et al., (2000) [10]. Abd El-Aziz and Amal Helmy (2001) [1] studied variation in the six alfalfa cultivars: viz Ismailia 1 and 94, Siwa-1, New Valley, Salt tolerant and introduced cultivar WL-605. Significant differences were found among the studied genotypes for dry yield, plant height and leaf/stem ratio. The cultivars WL-605, New Valley and Ismailia 94 were superior to the others for dry yield and leaf/stem ratio. However, Siwa and Ismailia 1 cultivars possessed largest values for plant height. Oushy et al. (2007) [20] studied the variability of forage yield and quality in a three exotic alfalfa cultivars imported from USA and two local cultivars, Ismailia and Siwa, at two different environment conditions, Ismailia and the New Valley Agric. Res. Stations. Results showed that the local cultivars Ismailia-1 and Siwa were superior in yielding capacity and distribution to the exotic cultivars at two locations. Abdel-Galil and Hamed (2008) [4] evaluated nine cultivars of alfalfa under the New Valley environment. Significant differences were reported among the cultivars and between years for all studied traits, i.e. fresh and dry forage yields, plant height, tillers number and leaf to stem ratio. In addition to, significant positive correlation among either fresh or dry forage yields and other traits. Also, the values of genotypic coefficient of variation for fresh and dry forage yields revealed relative variation among the tested cultivars which were less influenced by environment. Benabderrahim et al. (2009) [9] evaluated twenty cultivated populations of alfalfa for morphological and yield traits. Results indicated that the large significant difference among those studied genotypes can be attributed to genetic variability among individual plant within an accession for tested traits such as plant height, total fresh and dry matter. Moreover, correlation between yield and morphological traits shows that dry matter is negatively correlated to stem length (-0.61) and positively to stem diameter (0.43). Fresh matter was negatively correlated to seed weight (0.31) and positively to leaf dimension. Avci et al. (2010) [7] reported that significant differences were found among alfalfa lines and cultivars in dry matter yield, plant height and quality traits in three respective years. Rezaei et al. (2010) [23] studied the variability and correlation among some traits of eighty one ecotypes of (*Medicago sativa*) collected from different areas of Iran. High variation was observed among ecotypes for all the evaluated characteristics. Correlation coefficient among traits indicated that the role of stem in forage yield is more pronounced than that of the leaf. Also, the correlation between the ratio of leaf to stem and forage yield was observed as negative and significant. Therefore, the components most affecting forage quantity plant height and stem weight. Davodi et al. (2011) [12] reported that dry matter yield was positively correlated with each of plant height and stem number. Otherwise, it was negatively correlated with leaf/stem ratio.

2. Materials and Methods

This study was carried out at the New Valley Agricultural Research Station, El-Kharga Oasis, Egypt, during two successive growing seasons of 2007/2008 and 2008/2009. The genetic materials for this study comprised three Egyptian (local) and three exotic varieties obtained from the Forage Crop Department (ARC), Ministry of Agriculture, Giza, Egypt. The origin of these varieties is presented in (Table 1).

Table 1. The origin of studied varieties.

Number	Variety	Origin
1	Wady France	France
2	Wady Local	Egypt
3	Siriver	Austrilay
4	Melissa	France
5	Ismailia 1	Egypt
6	Nubaria	Egypt

In November 20th, 2007 season; the six varieties had planted in a Randomized Complete Blocks Design (RCBD) with three replications. The plot size was 6 m2. Each variety was seeded at the rate of 30 g/plot (20 kg/fed.). Plots received 60 kg/fed of P2O5, 96 kg/fed of K_2O before emergence and 20 kg/fed nitrogen after emergence. The first irrigation applied eight days after sowing. The following irrigations applied at ten days in summer and fifteen days in winter. The first cut was taken in February 1st, 2008, then six cuts were taken in each season (2007/2008 and 2008/2009).

***Traits studied*:**

1. Plant height, cm: Mean plant height in centimeters was determined at harvest in each cut by average 10 plants measurements from soil surface to the tip of the tallest tiller and averages.
2. Number of tillers/m^2: Number of tillers/m^2 was determined as an average.
3. Leaf/plant ratio: Plant samples separated to leaves and stem were used to determine the leaves / plant ratio (dry weight basis).
4. Fresh forage yield, kg: fresh forage yield (kg/plot) was calculated.
5. Dry forage yield: dry forage yield (kg/plot) = fresh forage yield x mean dry matter percentage, where dry matter percentage was determined from random samples 150 g from each plot, after drying in oven at 70°C.

***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) according to Gomez and Gomez, (1984) [14,15]. Bartlett test of variance homogeneity was carried out before the combined analysis. Mean comparison were performed using least significant difference (L.S.D.) at 5% level of probability.

Phenotypic (P.C.V.) and genotypic (G.C.V.) coefficients of variability for the studied traits were calculated according to Burton (1952) [11], as follows =

$$G.C.V. = \frac{\sqrt{\sigma_g^2}}{\overline{X}_G} \times 100 \quad , \quad P.C.V. = \frac{\sqrt{\sigma_p^2}}{\overline{X}_G} \times 100$$

Where $\overline{X}_G$ = the general mean

The phenotypic correlation coefficients were computed from the components of variance and covariance as outlined by Johnson et al (1955) [17].

Path-coefficient analysis was carried out according to the procedure outlined by Dewey and Lu (1959) [13].

3. Results and Discussion

The analysis of variance in Table 2 revealed a highly significant difference among the studied alfalfa genotypes for plant height, number of tillers/m^2, leaf/plant ratio, seasonal fresh and dry forage yield/plot in both successive seasons. This result confirms the variable response of alfalfa genotypes to the New Valley environmental conditions. Moreover, the combined analysis of variance (Table 3) showed highly significant differences between seasons and among varieties for all studied traits. Also, year x variety interaction was significant for plant height, leaf/plant ratio and dry forage yield/plot. This significant interaction, might indicate, variable variatal response from year to another. These results are in line with those obtained by Oushy et al. (1999), Hefiny (2007); Abdel-Galil and Hamed (2008) [4,16,18,21]. They found a significant difference among alfalfa cultivars and between years for fresh and dry forage yields, plant height, number of tillers and leaf/stem ratio.

Means of the studied genotypes over six cuts for the studied traits plant height, number of tillers/m2, leaf/plant ratio, seasonal fresh and dry forage yield/plot, in 2007/2008, 2008/2009 are presented in Table 4. Data revealed that the Wady local genotype enjoyed the highest values in all studied traits and recorded values of 68.6, 81.1 cm; 472.0, 644.0 with an average of 558.0, 45.8, 47.4 %; 104.3, 106.5 with an average of 105.4 kg and 19.1, 27.7 kg for plant height, number of tillers/m2, leaf/plant ratio, seasonal fresh and dry forage yield/plot in the two successive seasons, respectively.

The genotype of Nubaria was significantly the second in performance for the previous traits.

Meanwhile, Siriver as the exotic genotype was commonly except for plant height that was significantly similar to El wady local the least where, recorded 51.7, 60.3 cm; 398.7, 511.6 and 455.1; 43.4, 44.3 %; 59.0, 68.0 and 63.5 kg and 12.4, 16.1 kg in 2007/2008; 2008/2009 for the aforementioned traits, respectively.

In second growing season, the studied traits possessed higher values than the first one which recorded general means of 70.9 cm, 578.6, 46.0%, 85.5 and 22.0 kg for plant height, number of tillers/m2, leaf/plant ratio, fresh and dry forage yield/plot in the two successive seasons, respectively. This might explane 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) [2,4,5,8,22].

Phenotypic and Genotypic coefficients of variation.

Phenotypic P.C.V. coefficients of variation Table 4 ranged between 1.9 and 21.0% for leaf/plant ratio (%) and fresh forage yield/plot, kg traits.

Also, the genotypic G.C.V. coefficients of variation ranged between 1.7 and 20.9%for leaf/plant ratio (%) and fresh forage yield/plot traits. The magnitude of P.C.V. was greater than G.C.V. indicating that characters are highly influenced by genetic and environment factors. These results confirmed with those reported by Abdel-Galil (2007) [3].

Phenotypic correlation analysis:

The genetic cause of correlation is chiefly pleiotropy. Although, linkage is a cause of transient correlation, particularly in populations derived from crosses between divergent strains. Besides, the environment is a cause of correlation in so far as two traits are influenced by the same differences of environmental conditions Falconer (1960) [14].

Phenotypic correlation coefficients Table 5 were calculated using means of the studied traits over all years. All values of correlation coefficient were positive, highly significant, and reached recorded more than 0.95. The highest strong and positive estimates were found between number of tillers/m^2 and each of dry forage yield/plot (0.9975) and fresh forage yield/plot (0.9947). Moreover, the correlation coefficients among other traits, exhibited the same trend. These results are in line with those obtained by Annicchiarico (2006) [6] and Monirifar (2011) [18] who found strong and positive correlation between plant fresh and dry forage weights.

Table 2. Analysis of variance for plant height, number of tillers/m2, leaf/plant ratio, fresh and dry forage yield /plot over six cuts in 2007/2008 and 2008/2009 seasons.

S.O.V.	d.f.	Plant height, Cm		Number of tillers/m^2		Leaf/plant ratio (%)		Fresh forage yield/plot, kg		Dry forage yield/plot, kg	
		2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
Rep.	2	20.9*	1.9	676.3	62.9	0.2	0.1	21.9	16.9	2.9**	0.9
Var.	5	130.1**	200.5**	2419.5**	7248.2**	2.0**	5.4**	840.2**	619.2**	16.5**	56.3**
Error	10	4.9	3.2	399.2	232.3	0.3	0.2	8.5	5.1	0.4	0.3

*, **: indicate significant at 0.05 and 0.01 levels, respectively.

Table 3. Combined analysis for studied traits over the two seasons 2007/2008 and 2008/2009.

S.O.V.	d.f.	Plant height, cm	Number of tillers/m^2	Leaf/ plant ratio (%)	Fresh forage yield/ plot, kg	Dry forage yield/ plot, kg
		Mean squares				
Years (Y)	1	826.6**	188081.2**	15.5**	339.5**	365.1**
Rep/ year	4	11.4	369.4	0.2	19.4	1.9
Varieties (V)	5	314.9**	8983.5**	6.2**	1450.6**	66.5**
Y. x V.	5	15.8*	685.7	1.2**	8.8	6.2**
Error	20	4.1	315.3	0.2	6.8	0.3

*, **: indicate significance at 0.05 and 0.01 levels, respectively

Table 4. Means of varieties P.C.V. and G.C.V. for plant height (cm), number of tillers/m2, leaf/plant ratio (%), fresh and dry forage yield/plot (kg) in 2007/2008 and 2008/2009 seasons.

Varieties	Plant height, Cm		Number of tillers/m^2			Leaf/plant ratio (%)		Fresh forage yield/plot, kg			Dry forage yield/plot, kg	
	2007/08	2008/09	2007/08	2008/09	Mean	2007/08	2008/09	2007/08	2008/09	Mean	2007/08	2008/09
1- Wady France	55.0	64.4	411.3	541.8	476.6	45.0	44.8	66.1	73.5	69.8	14.2	18.5
2- Wady local	68.6	81.1	472.0	644.0	558.0	45.8	47.7	104.3	106.5	105.4	19.1	27.7
3- Siriver	51.7	60.3	398.7	511.6	455.1	43.4	44.3	59.0	68.0	63.5	12.4	16.1
4- Melissa	62.8	67.2	423.6	562.2	492.9	44.2	45.4	72.8	80.3	76.6	15.0	21.1
5- Ismailia 1	64.2	77.8	438.2	596.5	517.3	44.7	46.8	83.0	89.2	86.1	16.0	23.2
6- Nubaria	65.8	74.7	460.5	615.6	538.0	44.9	46.9	90.9	95.5	93.2	17.2	25.5
Mean	61.4	70.9	434.0	578.6	506.3	44.7	46.0	79.4	85.5	82.4	15.7	22.0
L.S.D 0.05%	4.0	3.3	36.4	27.7	N.s	0.9	0.7	5.3	4.1	N.s	1.1	1.0
P.C.V. %	10.7	11.5	6.5	14.6	7.64	1.9	2.9	21.0	16.8	18.87	14.6	19.5
G.C.V. %	10.6	11.4	6.0	14.5	7.35	1.7	2.8	20.9	16.7	18.81	14.6	19.5

1. least significant difference at 0.05 level for separate seasons; 2. least significant difference at 0.05 level for combined analysis

Table 5. Correlation coefficients among plant height, number of tillers/m2, leaf/plant ratio, fresh and dry forage yield/plot estimated over the two years.

	Number of tillers/m^2	Leaf/plant ratio (%)	Fresh forage yield/ plot, kg	Dry forage yield/plot, kg
Plant height, cm	0.9718**	0.9555**	0.9639**	0.9710**
Number of tillers/m^2	--	0.9736**	0.9947**	0.9975**
Leaf/plant ratio (%)	--	--	0.9725**	0.9710**
Fresh forage yield/ plot, kg	--	--	--	0.9931**

** significant at the 0.01 level of probability.

Table 6. Partitioning of phenotypic correlation into direct and indirect effects by path-coefficient analysis for some alfalfa varieties

1- Plant height vs. fresh forage yield/plot	r= 0.9639
Direct effect, P14 ……	= -0.0645
Ind. effect via no. of tillers/m^2, r12P24 ……..	= 0.9429
Ind. effect via leaf/plant ratio %, r13P34 …….....	= 0.0855
2- No. of tillers/m^2 vs. fresh forage yield/plot	r= 0.9947
Direct effect, P24 ……...	= 0.9702
Ind. effect via plant height, r12P14 …….....	= -0.0626
Ind. effect via leaf/plant ratio %, r23P34 …….....	= 0.0871
3- Leaf/plant ratio % vs. fresh forage yield/plot	r= 0.9725
Direct effect, P34 ……	= 0.0895
Ind. effect via plant height, r13P14 …….	= -0.0616
Ind. effect via no. of tillers/m^2, r23P24 …….....	= 0.9446
4- 1= P2x4 + P214 + P224 + P234 + 2P14r12P24 + 2P14r13P34 + 2P24r23P34	
Px4	= 0.1006

Path-coefficient analysis

The forage yield components have a direct and indirect effect on forage yield. Path-coefficient, which is a standardized partial regression coefficient Wright (1921) [24], permits the separation of correlation coefficient into measures of direct and indirect effects, and provides a critical examination of the specific forces acting to produce a given correlation. Also, it measures the relative importance of each causal factor.

The partitioning of phenotypic correlation into direct and indirect effects by path-coefficient analysis for plant height, number of tillers/m2, and leaf/plant ratio (%) on fresh forage yield/plot for some alfalfa varieties are presented in Table 6. Results revealed that the strongly positive direct and indirect effects were reported for number of tillers/m2 on fresh forage yield/plant.

This direct effect of number of tillers/m2 on fresh forage yield/plot was 0.9702. Moreover, the indirect effects of this trait through plant height and leaf/plant

ratio were 0.9429 and 0.9446, respectively. The neglected values of direct and indirect effects were found for other studied traits on fresh forage yield/plot.

These results confirm the powerful direct and indirect effects of number of tillers on fresh forage yield for alfalfa.

Consequently, the selection for number of tiller will be more benefit for fresh forage yield and consequently dry forage yield. These results are in harmony with those obtained by Abdel-Galil (2007) [3], who reported that, the path-coefficient analysis indicated that, the number of tillers/plant was the most prominent indirect effect (51.8%) on fresh forage yield of alfalfa.

Compliance with Ethics Requirements: Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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