

Full Length Research Paper

Forage yield components of various alfalfa (*Medicago sativa* L.) cultivars grown on salt-affected soil under rainfed and irrigated conditions in a Mediterranean environment

Abed Chedjerat^{1,3*}, Mahfoud M'hammedi Bouzina², Abdelhamid Gacemi³ and Aissa Abdelguerfi¹

¹National Higher School of Agronomy, ENSA of El Harrach, Algiers, Algeria.

²Department of Agronomy, SNV Faculty, University of Hassiba Benbouali, Chlef, Algeria.

³National Agronomic Research Institute of Algeria, Station of Hmadna, Algeria.

Received 30 March, 2016; Accepted 26 July, 2016

In Algeria, the area allocated to crop fodders in particular, the alfalfa (*Medicago sativa* L.) is very limited as compared to other crops. Some obstacles hinder the development of crops especially in irrigated perimeters. A field experiment was conducted to highlight the adaptation of sixteen (16) alfalfa varieties from different origins (Algeria, Australia, France, Italy, Morocco, Tunisia and USA) to drought, soil salinity and to evaluate the dry matter yields in the experimental station INRAA of Hmadna in the Lower-Cheliff plain in two cropping seasons, 2005/2006 and 2006/2007. The tests were conducted in a saline soil under two water regimes, rainfalls and irrigation with the maximum evapotranspiration. The evaluation focuses on dry matter yield, plant height and stand density. The results obtained in two campaigns show the encouraging production of dry matter of some varieties such as "Amerstrand 801S" and the weak production of the local variety "Tamantit", a reduction in the number of plants per square meter from one year to another, and an average height of the plants which differs from a variety to another. The number of harvests per season was normally between 4 and 6. It is concluded that some varieties are suitable for dry matter production in salt affected soil under both water regimes in the area of Hmadna in the Lower-Cheliff plain (Algeria).

Key words: Algeria, alfalfa, cultivar, dry matter yield, plant height, stand density.

INTRODUCTION

Alfalfa, *Medicago sativa* L. is one of the most widespread forage plants in the world. Grown in equatorial regions to

the limits of the Arctic Circle, however, its greatest development is found in warm temperate areas. Alfalfa

*Corresponding author. abedchedjerat@gmail.com. Tel. +213773906922.

Table 1. Monthly average temperature (T) and monthly total rainfall (R) of the growing seasons, 2005/2006 and 2006/2007.

Month	2005		2006		2007	
	T _m (°C)	Rainfall (mm)	T _m (°C)	Rainfall (mm)	T _m (°C)	Rainfall (mm)
September	24.61	14.9	25.58	0.7	26.32	34.00
October	21.44	20.9	22.93	1.8	20.42	47.00
November	14.12	75.9	17.19	0.3	15.56	32.2
December	11.57	36.8	13.01	70.4	10.90	5.4
January	7.67	4.10	09.20	29.6	10.71	46.3
February	13.86	50.80	09.75	71.6	13.42	24.7
March	14.08	14.50	13.96	7	12.74	56.5
April	16.03	3.7	19.46	17.3	15.24	108
May	23.25	0.7	24.77	37.6	21.08	19.2
June	27.37	0.2	26.16	00	25.28	0
July	30.67	0.1	31.57	0.4	29.76	0.4
August	27.69	00	28.12	0	29.06	0

Table 2. Some characteristics of the studied soil (0-35 cm depth).

Characteristics	Values	Characteristics	Values
Clay (%)	45.50	Ca meq/100 g	28.34
Sand (%)	12.12	Mg meq/100 g	6.17
Silt (%)	42.34	Na meq/100 g	2.51
pH	7.72	K meq/100 g	1.46
CE dS/m	6.89	P ₂ O ₅ ass	89.88
Bulk density	1.78	Mo %	3.81

usually has the highest feeding value of all common hay crops. Addition of alfalfa to lamb diets enhances production and profits (Rong et al., 2014).

Perennial alfalfa is one of the most adapted species to drought (Lemaire 2006). Its life cycle gives it the ability to contribute to the sustainability of rain fed cropping systems (Volaire and Norton, 2006). The alfalfa plant can cover its needs from the water loss through evaporation and the loss of soil, it is also vulnerable to wind and hydric erosion. The global area occupied by alfalfa is about 12.5 million hectares producing 324.5 million tons in 2013 (FAOSTAT, 2015). African production is about 5.32 million tons over an area of 185 000 ha. In 2013, Algeria produced only 29,000 tons on an area of 3,000 ha (FAOSTAT, 2015). In arid Mediterranean areas, alfalfa is often irrigated and often challenged with a saline stress. Search for varieties best adapted to this situation is a priority (Ibriz et al., 2004). In Algeria, the establishment of performance tests from introduced species and varieties could be a way of research in order to choose the best perennial alfalfa cultivars. The main objective of this study is to evaluate some forage yield components of 16 alfalfa, *M sativa* cultivars from different origins under the climatic conditions of the region of Hmadena in north-western of Algeria.

MATERIALS AND METHODS

Site description and climatic conditions

The tests were performed during two successive campaigns: 2005/2006 and 2006/2007, on sixteen (16) alfalfa varieties from different origins, at the experimental station of Hmadna, Algeria (35° 54 'N and 0° 47 'E with an altitude of 48 m) belonging to the National Institute of Agronomic Research of Algeria. The study area is characterized by a semi-arid to arid climate trend where irrigation is essential for crops. Monthly average temperature (T) and monthly total rainfall (R) of the growing seasons 2005/2006 and 2006/2007 are shown in Table 1. The soil of the experimental area is of a loamy-clay texture with a higher electrical conductivity of the irrigated environment relative to 6.0 vs. 5.20 dS m⁻¹ which was consistent with the expected increase of soil salinity caused by irrigation with moderately saline water featuring 3.40 dS m⁻¹ electrical conductivity (Annicchiarico et al., 2010). Some physical and chemical characteristics of the studied soil of the experimental area are presented in Table 2.

Plant materials, experimental design and cultivation practices

The experiment was conducted at Hmadna on fields cultivated under two water regimes: a rainfed system without any irrigation supply during the two experimental seasons and an irrigated system where the quantity of water supplied is equal to the ET_m. Seed bed preparation included ploughing, disk harrowing and cultivation. Weed control was performed manually. Sowing was

Table 3. Names and origins of the tested cultivars.

Name of cultivars	Origin	Name of cultivars	Origin
Ecotipo siciliano	Italy	Gabes 2355	Tunisia
Prosementi	Italy	Magali	France
ABT 805	USA	Melissa	France
Ameristrand 801S	USA	Coussouls	France
Mamuntanas	USA	Africaine	Morocco
Tamantit	Algeria	Rich2	Morocco
Sardi 10	Australia	Erfoud1	Morocco
Siriver	Australia	Demnat	Morocco

performed by hand during the second week of October 2004 with 25 kg ha⁻¹ seed rate for all varieties which is considered appropriate to combine forage and seed production (Lloveras et al., 2008). As these are selected cultivars, seed purity was 100% as well as germination percentage. Sixteen perennial alfalfa cultivars were placed on two plots with 4 replications with row spacing of 0.20 m. Each plot is consists of 16 micro plots of 2.50 m length and 2 m wide with a spacing of 0.20 m between microplot and 0.4 m between blocks. Table 3 shows the name of each variety and origin country. Harvest started as soon as 75% of seedlings in the elementary plot reached 0.35 m height for the winter season and 50% of flowering in most of plots for the spring and summer seasons.

The cuts are made at 0.05 m from the ground level and the yield is calculated in dry matter (DM). Each collected sample was weighed and passed to the drying oven for 80°C during a period of 48 h. Four cuts were performed for test in rainfed and 6 cuts for irrigated test.

The density of the initial and final stand were evaluated by counting the number of plants per m² for each of the 16 varieties in each replicate for both tests (rainfed and irrigated). Plant height was recorded on 18 plants taken randomly by repetition and for each variety in both trials.

Statistical analysis

The analysis of variance test (ANOVA) was applied on the data with mean separation of 5%. Levels of significance averages of various repetitions were calculated and analyzed by the statistical software (STATBOX 6.0.4.) and the used device is the unifactorial total randomization by the test of Newman and Keuls ($P_{0.05}$ and $P_{0.01}$).

RESULTS AND DISCUSSION

Stand density

Statistical analyses of each test and for each season show that there are no significant differences between all the varieties studied concerning the numbers of plant/m². Whereas, high significant differences were obtained among stand densities when compared the results of 2005/2006 season with those of 2006/2007 for tests conducted in rainfed. Significant differences existed also between the results of tests conducted in irrigated for the

year 2005/2006 and 2006/2007. The result of statistical analysis of densities between the rainfed tests and irrigated one for the season 2006/2007 reveals insignificance.

The highest density was marked for the variety, Ecotipo Siciliano with 72 plants /m² recorded in 2005/2006 in the test leads in irrigated. This variety kept its values in first rank for the test carried out in rainfed with 50 plants per m² for the same year. On one hand, these results join those of Chocarro and Lloveras (2014) who found a stand density reaching 70 plants per m² with spacing of 20 cm between rows which is the same spacing used in this experiment.

On the other hand, the lowest densities were recorded in "Tamentit", African and Demnat203 cultivars with 30, 32.5 and 32.5 plants per m² respectively for the test carried out in rainfed and 55, 40 and 50 plants per m² respectively in the irrigated trial for the same season (2005/2006), with a regression of density for the same varieties in 2006/2007. The stand densities at the end of each campaign are given in Table 4.

Plant height

As one of the most important forage yield components, the average plant heights of alfalfa seedling were calculated during all seasons of 2005/2006 and 2006/2007 in both water regimes (Table 5). The results show that the highest plants are between 28.56 and 28.06 cm in Ameristand 801S and Melissa varieties, respectively, during 2005/2006 under rainfed. The height of the local variety seems low with an average of 20.37 cm. For the tests in irrigated plots in the same season (2005/2006), the heights of the plants were higher than in rain with 37.58 cm for Ameristand 801S and 36.63 cm for Demnat.

In addition, for the second season (2006/2007), the Ameristand 801S variety had the highest average with 36 cm for the test in rainfed and 39.91 cm for the test in irrigated. The average heights for the local variety Tamentit were 32.37 cm in rainfed and 33.37 in irrigated.

Statistical analysis of data showed highly significant differences among all cultivars examined for two campaigns from both tests (rainfed and irrigated). These results are proximate to those found by Mikic et al. (2005) where they obtained significant differences in the heights of plants among all studied cultivars and Katic et al. (2006) obtained plants heights which varied between 36.4 and 68.9 cm in alfalfa grown between 2003 and 2004 in Serbia.

The averages of plant height obtained in these experiments seem lower than those found by Mikic et al. (2005) and Katic et al. (2006). This could be explained by the soil type of the study, which is known by its salinity and by the climate which is semi-arid and also by the use of different plant material. Mikic et al. (2005) and Katic et al. (2006) obtained plant heights varied between 36.4 and

Table 4. Stand density per m² of the 16 alfalfa varieties.

Season	2005/2006		2006/2007	
	Rainfed	Irrigated	Rainfed	Irrigated
Cultivars	Plants/m ²	Plants/m ²	Plants/m ²	Plants/m ²
Ecotipo siciliano	50	72.5	22.5	37.5
Prosementi	35	52.5	15	25
ABT 805	35	55	17.5	40
Ameristand 801S	32.5	67.5	12.5	42.5
Mamuntanas	47.5	60	22.5	37.5
Tamantit	30	52.5	10	27.5
Sardi 10	32.5	52.5	12.5	35
Siriver	35	42.5	17.5	32.5
Africaine	32.5	40	15	22.5
Gabes-2355	45	50	17.5	27.5
Magali 1	37.5	57.5	22.5	27.5
Melissa	37.5	60	20	37.5
Cousouls	37.5	55	17.5	32.5
Rich 2	37.5	42.5	15	32.5
Erfoud 1	35	50	17.5	37.5
Demnat 203	32.5	50	10	37.5
SEM	13.05	16.45	8.22	10.18
Prob.	0.70	0.37	0.49	0.23
Sig.	N.S	N.S	N.S	N.S
C.V (%)	35.24	30.62	49.68	30.59

NS: Non-significant; Sig: significance level; SEM: standard error mean; CV: coefficient of variance.

68.9 cm in alfalfa grown between 2003 and 2004 in Serbia.

Comparison of average heights of alfalfa plants obtained in rainfed tests in the 2005/2006 season with the averages of 2006/2007 shows non-significant differences between the two seasons. Meanwhile, highly significant differences were obtained when comparing the average heights of plants in irrigated test for the season of 2005/2006 to 2006/2007.

Forage yield

In this study, the forage DM yield (DM) on both experiments in irrigated and rainfed during 2005/2006 and 2006/2007 period were presented. The number of the cuts per season was 6 in irrigated plots and 4 cuts in rainfed. Bellague et al. (2008) obtained 4 alfalfa cuts for the same varieties in rainfed and 6 cups for irrigation in 2004. Fanlo et al. (2006) obtained six alfalfa cuts in a test carried out in irrigated plots and 3 cuts in rainfed tests conducted in Girona (Spain) which is characterized by similar climatic conditions of the region.

The results of field trials studied under different water regimes show a dry matter yield varying from 6.13 to

13.44 t ha⁻¹ for all varieties in irrigated conditions. Therefore, in rainfed conditions, the yield varied between 2.27 and 4.69 t ha⁻¹. For the 1st season in the rainfed plots, the most productive varieties in order of importance are: Ameristrand 801S, Mamuntanas, Melissa and Riche2 and less productive are: Tamentit, Prosementi, Cousouls and Magali and for irrigated plots, the varieties, Ameristrand 801S, Mamuntanas, Melissa and Riche2 were the most productive and Tamentit, Prosementi, Cousouls and Magali were less productive varieties (Table 6). For the 2nd season (2006/2007), the variety Mamuntanas, Erfoud, Riche2 and Siriver had the best yield in DM. Unlikely, varieties such as Tamentit, Prosementi, Demnat and Cousouls still had the lowest yield. Tables 7 and 8 show the forage yield results by cuts and by period (in dry and irrigated) for both seasons. Khelifi et al. (2008) achieved an average DM yield balance of 2.59 to 7.11 t ha⁻¹ for the same varieties with rainfed trial conducted in the area of Algiers which is characterized by soil and climate of optimum conditions than the study area. For the irrigated trial, yields obtained range from 2.59 to 11.64 t ha⁻¹.

Benabderrahim et al. (2008) showed that the cultivar "Gabes" originating from the Tunisian oases presents small quantities of dry matter. The best fresh matter

Table 5. The plant heights of 16 alfalfa varieties for 2005/2006 and 2006/2007 under rainfed and irrigated conditions.

Cultivars	2005/2006		2006/2007	
	Rainfed	Irrigated	Rainfed	Irrigated
	Height (cm)		Height (cm)	
Ecotipo siciliano	21.68 ^{de}	34.41 ^{ab}	36 ^a	37 ^{abc}
Prosementi	18.56 ^e	29.58 ^b	31.62 ^a	34.04 ^{bcd}
ABT 805	23.5 ^{cd}	32.38 ^{ab}	33.37 ^a	34.87 ^{bcd}
Ameristand 801S	28.56 ^a	37.58 ^a	36 ^a	39.91 ^a
Mamuntanas	27 ^{abc}	35.17 ^{ab}	31.75 ^a	37.87 ^{abc}
Tamantit	20.37 ^{de}	30.21 ^b	32.37 ^a	33.37 ^{cd}
Sardi 10	24.31 ^{bcd}	33.88 ^{ab}	35.31 ^a	36.58 ^{abc}
Siriver	24.06 ^{bcd}	32.38 ^b	32.12 ^a	36.04 ^{abcd}
Africaine	21.43 ^{de}	30.63 ^b	32.5 ^a	34.33 ^{bcd}
Gabes-2355	24.31 ^{bcd}	33.17 ^{ab}	32.37 ^a	35.54 ^{abc}
Magali 1	18.75 ^e	32.17 ^{ab}	32.31 ^a	31.83 ^d
Melissa	28.06 ^{ab}	33.54 ^{ab}	34.75 ^a	37.87 ^{abc}
Cousouls	19.87 ^{de}	32.88 ^{ab}	31.56 ^a	33.46 ^{cd}
Rich 2	23.06 ^{cd}	30.92 ^{ab}	35.68 ^a	33.87 ^{cd}
Erfoud 1	24.56 ^{bcd}	35.96 ^{ab}	33.81 ^a	38.83 ^{ab}
Demnat 203	23.81 ^{bcd}	36.63 ^{ab}	35.93 ^a	38.75 ^{ab}
SEM	2.018	2.91	1.778	2.015
Prob.	0	0.007	0.00021	0
Sig.	**	**	**	**
C.V (%)	8.68%	8.77%	5.29%	5.61%

NS= no significant; *:significant at $P < 0.05$; **:Highly significant at $P < 0.01$. a, b, c, d: homogeneous group (numbers with the same letter are not significant different at $P < 0.05$). Sig: Significance level. SEM: standard error mean, CV: coefficient of variance.

yield is recorded in the cultivar Sardi (Australian origin). The cultivar, African (Moroccan origin) was most productive dry matter. Fanlo et al. (2006) showed that the average yield in rainfed conditions is between 1.3 and 6.3 t ha⁻¹ and that of irrigated test is higher with an average of 8 to 22.5 t ha⁻¹. These results on the influence of the varieties on the dry matter yield correspond to those of Stanisavljević et al. (2012) who recorded an average DM yield between 2.59 and 6.54 t ha⁻¹ depending on cultivars. Average DM yields among 18.8 and 7.48 t ha⁻¹ have been reported during an experimentation in Spain by Delgado et al. (2013) and Chocarro and Lloveras (2014). The statistical analyses of data show that there are highly significant differences between varieties in relation to the yields. The average of DM yield ranges from 8.6 to 20.4 t ha⁻¹ depending on the results obtained by Katic et al. (2006) who confirm that these changes are significantly dependent on the cultivar. Van Heerden (2012) reported that the average of DM yield of all varieties in rainfed trial increased in the second year as compared to the first season from 3.36 to 4.75 t ha⁻¹. Otherwise, for the irrigated tests, the average yield in the first season (9.53 t ha⁻¹) is higher than that of the second campaign (8.57 t ha⁻¹). This increase in production of

rainfed test is mainly due to the good distribution of rainfall during the spring season (Van Heerden, 2012).

Karagic et al. (2005) demonstrated that the climatic conditions of the cultivation region have a great effect on the yield of alfalfa which varied from 5.38 to 8.85 t ha⁻¹. The variations in this study area were mainly subject to the influence of climatic conditions.

Conclusion

The main objective of this study was to assess forage yield components of 16 alfalfa, *M. sativa* L. varieties from different origins under soil and climatic conditions of the Hmadna region in the North West of Algeria during two campaigns in 2005/2006 and 2006/2007.

Based on the results obtained in the experiment, it is suggested to cultivate varieties Ameristrand 801S, ecotipo Siciliano Mamuntanas and Erfoud1 under an irrigation system at maximal evapotranspiration, other cultivars as Mamuntanas, Melissa, and Erfoud1 Siriver can be conducted under rainfed.

In this region characterized by a semi-arid to arid tendency and clay loamy soils with moderate salinity to

Table 6. Dry matter forage yield t ha⁻¹ of 16 alfalfa varieties for the 2005/2006 and 2006/2007 seasons in rainfed and irrigated conditions.

Cultivars	2005/2006		2006/2007	
	Rainfed	Irrigated	Rainfed	Irrigated
	DM yield		DM yield	
Ecotipo siciliano	3.51 ^{cd}	11.38 ^b	5.14 ^{bcd}	9.75 ^b
Prosementi	2.32 ^e	7.96 ^f	3.92 ^{fg}	7.41 ^g
ABT 805	3.44 ^{cd}	9.86 ^d	4.53 ^{ef}	8.97 ^{cde}
Ameristand 801 S	4.29 ^{ab}	13.44 ^a	4.64 ^{de}	10.94 ^a
Mamuntanas	4.68 ^a	11.09 ^b	6.42 ^a	9.94 ^b
Tamantit	2.27 ^e	7.57 ^{fg}	3.61 ^g	7.79 ^{fg}
Sardi 10	3.55 ^{cd}	10.53 ^{cd}	4.80 ^{cde}	9.09 ^{cd}
Siriver	3.92 ^{bc}	8.95 ^e	5.13 ^{bcd}	8.97 ^{cde}
Africaine	3.15 ^d	6.13 ^h	4.19 ^{efg}	6.81 ^h
Gabes-2355	3.69 ^{cd}	8.52 ^e	4.48 ^{ef}	8.49 ^{de}
Magali 1	2.55 ^e	8.53 ^e	4.60 ^{de}	6.99 ^h
Melissa	3.99 ^{bc}	9.52 ^d	5.58 ^b	8.37 ^{ef}
Cousouls	2.37 ^e	11.26 ^b	4.18 ^{efg}	7.86 ^{fg}
Rich 2	3.35 ^{cd}	7.34 ^g	5.25 ^{bc}	7.14 ^h
Erfoud 1	3.49 ^{cd}	11.35 ^b	5.70 ^b	9.17 ^c
Demnat 203	3.14 ^d	9.03 ^e	3.93 ^{fg}	8.36 ^{ef}
SEM	2.916	2.859	2.968	3.337
Prob.	0	0	0	0
Sig.	**	**	**	**
CV	8.68%	3.00%	6.23%	3.92%

NS= no significant; *: significant at P < 0.05; **: Highly Significant at P < 0.01. a, b, c, d: homogeneous group (numbers with the same letter are not significant different at P < 0.05). Sig: Significance level. SEM: standard error mean, CV: Coefficient of variance.

Table 7. Forage yield of alfalfa per cuts in both water regimes for 2005/2006.

Cultivars (2005/2006)	Forage yield in irrigated test (t.ha ⁻¹)						Forage yield in rainfed test (t.ha ⁻¹)			
	1 st cut	2 nd cut	3 rd cut	4 th cut	5 th cut	6 th cut	1 st cut	2 nd cut	3 rd cut	4 th cut
Ecotipo siciliano	1.03	2.78	2.35	2.07	1.91	1.24	1.43	0.94	0.72	0.42
Prosementi	0.42	1.48	1.87	1.70	1.55	0.94	0.97	0.56	0.52	0.26
ABT 805	1.58	2.55	1.91	1.73	1.34	0.71	2.15	0.52	0.51	0.26
Ameristand 801 S	2.16	2.64	2.54	2.37	2.36	1.37	2.31	0.90	0.81	0.27
Mamuntanas	1.76	2.73	2.03	1.97	1.68	0.93	2.43	1.01	0.78	0.45
Tamantit	0.87	0.99	1.49	1.35	1.80	1.07	0.95	0.51	0.57	0.25
Sardi 10	1.58	2.15	2.05	1.88	1.75	1.12	1.74	0.93	0.64	0.25
Siriver	1.34	2.08	2.00	1.66	1.23	0.64	1.87	1.0	0.64	0.41
Africaine	0.55	1.15	1.22	1.37	1.23	0.62	1.12	0.72	0.95	0.37
Gabes-2355	1.53	1.63	1.49	1.33	1.54	1.01	1.84	0.59	0.90	0.36
Magali 1	0.77	2.09	1.45	1.77	1.53	0.92	0.78	0.59	0.81	0.38
Melissa	1.60	2.11	1.86	1.65	1.46	0.85	1.67	0.96	0.97	0.41
Cousouls	1.14	2.57	2.36	2.00	2.02	1.17	1.14	0.54	0.45	0.25
Rich 2	0.93	1.75	1.35	1.54	1.17	0.61	1.66	0.68	0.60	0.42
Erfoud 1	1.40	2.35	2.34	1.92	2.07	1.27	1.50	0.77	0.79	0.44
Demnat 203	1.15	1.40	2.35	1.37	1.81	1.34	1.46	0.64	0.74	0.30

Table 8. Forage yield of alfalfa per cut in both water regimes for 2006/2007.

Cultivars (2006/2007)	Forage yield in irrigated test (t.ha ⁻¹)						Forage yield in rainfed test (t.ha ⁻¹)			
	1 st cut	2 nd cut	3 rd cut	4 th cut	5 th cut	6 th cut	1 st cut	2 nd cut	3 rd cut	4 th cut
Ecotipo siciliano	0.51	1.51	4.20	1.92	1.28	0.33	1.72	2.28	0.69	0.50
Prosementi	0.58	0.85	3.10	1.61	1.05	0.23	1.08	2.02	0.53	0.31
ABT 805	0.88	1.36	4.01	1.71	0.76	0.26	1.52	2.19	0.51	0.31
Ameristand 801 S	1.35	1.69	3.70	2.22	1.64	0.35	1.67	1.90	0.81	0.26
Mamuntanas	0.96	1.74	4.16	1.84	0.96	0.29	2.71	2.49	0.79	0.43
Tamantit	0.78	0.86	2.60	1.87	1.42	0.27	1.02	1.55	0.55	0.51
Sardi 10	0.88	1.27	3.39	1.97	1.25	0.34	1.60	2.02	0.64	0.55
Siriver	0.83	1.21	3.88	1.83	1.02	0.21	1.87	2.35	0.61	0.31
Africaine	0.51	0.68	2.76	1.45	1.09	0.31	1.40	1.57	0.63	0.60
Gabes-2355	0.95	0.95	2.96	1.64	1.46	0.53	1.37	1.61	0.89	0.61
Magali 1	0.38	0.78	3.23	1.44	0.92	0.25	1.60	2.03	0.78	0.19
Melissa	0.74	1.25	3.19	1.67	1.22	0.31	1.81	2.24	0.91	0.64
Cousouls	0.37	1.18	3.71	1.49	0.98	0.15	1.46	2.12	0.44	0.17
Rich 2	0.59	1.06	3.03	1.38	0.92	0.16	1.76	2.38	0.69	0.44
Erfoud 1	1.00	1.33	2.76	2.30	1.40	0.39	1.80	2.44	0.78	0.58
Demnat 203	1.10	0.96	2.77	1.63	1.42	0.49	1.31	1.47	0.75	0.41

cultivate both cultivars Mamuntanas and Erfoud1 as long as these two cultivars gave acceptable yields in MS during the two campaigns under both water regimes, is proposed, especially the cultivar Erfoud1 of Moroccan origin from region a similar to this study area which gave satisfactory forage yields.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

This study was conducted within the EU-funded project PERMED. The authors are grateful to all the contributors in this project.

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