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Yield and Nutrient Efficiency of Five AlFalfa (*Medicago sativa* L.) Cultivars under Sandy Soil Conditions

A.B. El-Nasharty[1]; O.A.Nofal[2] and A.I. Rezk[1]

[1]Fertilization Technology and [2]Plant Nutrition Departments, National Research Centre, Dokki, Giza, Egypt.

Abstract: Five alfalfa cultivars (one Egyptian and four Chinese) were grown under sandy soil in the experimental farm of National Research Centre, at Nubaria District, located EL-Behara Governorate, Egypt to evaluate forage yield and nutritional status of plants. The cultivars were namely i.e. Nubaria (Egyptian cultivar); Chaoyinsu, Juneng, Liuji and Runbulexin (Chinese cultivars). The experimental design was a randomized complete blocks with three replications. A total of twenty-seven traits concerning content and uptake of macro- and micro-nutrients, fresh and dry forage yield, in addition to efficiency of nutrients absorption were determined for all cultivars. The results showed significant differences between alfalfa cultivars in all investigated traits. Nubaria Egypt cultivar recorded higher values than the other alfalfa cultivars for fresh and dry forage and crude protein yield and for the use and utilization efficiency and fertilizer recovery of macronutrients. However, Liuji Chinese cultivar recorded the highest values for concentration of N, protein, P, Mn and Cu and uptake of Fe and Cu. While, Juneng Chinese cultivar had favourable values from concentration of K and Zn and uptake of K and its use efficiency and fertilizer recovery percentage. But Chaoyinsu Chinese cultivar was superior of Fe concentration. Whereas, the maximum values of N and P utilization efficiency was obtained by Runbulexin Chinese cultivar. It is apparent that a sufficient variation could be used in breeding program for improving vegetative and chemical composition traits and then the nutritional value of alfalfa forage. Subsequently application of different crossing programs is recommended between Nubaria Egypt cultivar and Chinese cultivars to develop new alfalfa cultivars for sandy soil such as in Nubaria District, Egypt.

Keywords: Alfalfa, Cultivars, Dry forage yield, Chemical composition and sandy soil.

Introduction

Production of green herbage is attaining enormous importance, the world over, since demand for livestock products is increasing. Livestock production is substantially supported by seasonally available green forage available from a number of cultivated crops.

Alfalfa (*Medicago sativa* L.) is a widely grown perennial warm-season forage legume, that is grown on 30 million hectares worldwide. It produces forage of high nutritional quality, has positive influences on soil fertility and may be used in a number of different forms [1].It 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, 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"[2].In Egypt, there is a gap between production and demand of green forages, especially during the summer season, where the available forages are limited as a result of the competition from strategic crops on limited arable land. It is hardly possible to increase the area planted in old land and therefore 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 which is sandy soil, for producing high yields of high quality forage and longevity of stand. Factors affecting alfalfa high quality differ widely depending on many factors such as: soil fertility, cultivar, the presence of other species, the use of pesticides, climatic conditions, harvesting (season, time of day and stage of development at harvest) and the method of preservation [3]. In addition,[4] studied the seasonal variation in performance of alfalfa cultivars in sandy soil under sprinkler irrigation system. Differences in nutrient uptake and yield among cultivars of given species have been related to absorption, translocation, shoot demand, and dry matter production potentials per unit of nutrient absorbed [5,6,7]. Evaluation of nutritional status is an important part of experimental assessment since inadequate nutrition increases the risk of health and performance problems for livestock [8].Therefore, this study was aimed to evaluation of five alfalfa (*Medicago sativa* L) cultivars for yield and nutrient efficiency in sandy soil under sprinkler irrigation system.

Materials and Methods

A field experiment were carried out at newly reclaimed sandy soil in the Experimental Farm of the, National Research Centre, at Nubaria District, located EL-Behara Governorate, Egypt, in beginning of December , 2013. The aim of the present study is to comparison between one Egyptian alfalfa cultivar and four Chinese alfalfa cultivars* under sandy soil conditions with sprinkler irrigation system on forage yield and evaluates nutrient use efficiency. Representative soil sample was taken from one layer (0-30cm) in the experimental site before planting and prepared for analysis according to [9]. The results of physical and chemical analysis of the Experimental soil site were as follows: sand 91.2%, silt 3.7%, clay 5.1%, pH 8.3, organic matter 0.91 %, $CaCO_3$, 4.8 %, E.C 0.68 dSm^{-1}.While N,P,K, Fe ,Mn and Zn contents were : 319 , 9.7 , 46.6 , 3.2, 2.9 and 0.12 ppm, respectively.

Table (1): The origin of studied cultivars.

Number	Cultivar	Origin
1	Nubaria	Egypt
2	Chaoyinsu	China
3	Juneng	China
4	Liuji	China
5	Runbulexin	China

Alfalfa seeds were inoculated by the proper *Rizobium* and seeds were sown with the rate of 20 Kg fed^{-1}. Seeded on 1st December, 2013.Cultivars had sown in randomized complete blocks arrangement with three replications. The experimental area for each cultivar was $175m^2$. The Chinese alfalfa cultivars were namely; Chaoyinsu, Juneng, Liuji and Runbulexin while the Egyptian alfalfa cultivar was Nubaria(Table, 1). Basic fertilization, ammonium nitrate (33.5 % N) was applied as N fertilizer at a rate of 100 kg fed^{-1} on two equal doses after 21and 42 days from planting, calcium superphosphate (15.5 % P_2O_5) was applied at a rate of 150 kg fed^{-1} during land preparation and potassium sulphate (48% K_2O) was applied at a rate of 50 kg fed^{-1} with two doses with N fertilizer after 21and 42 days of planting. Other agricultural practices were used as recommended. The first irrigation was applied after eight days from sowing. The following irrigations were applied each fifteen days during winter season. Representative samples of ten plants were collected randomly from each plot before cutting. Leaf samples were taken from 4th to 7th leaf from each replicate and were analyzed by the standard methods according to [9].

The five cultivars of alfalfa were cutting after 60 days from sowing (first cut).Fresh and dry forage weights $plot^{-1}$ were determined and the productivity of each cultivar as ton fed^{-1} were calculated. Micronutrients, K and P were determined by Atomic absorption, Flame photometer and Spectrophotometer, respectively. Crude protein was calculated by multiplying total nitrogen percentage by factor of 6.25 [10].

* **Source**: Gansu Desert Control Research Institute (GDCRI), China

The N, P and K use and utilization efficiency and their Fertilizer Recovery were calculated according to [11] as follow:

1- Use efficiency (efficiency of nutrient absorption)=Nutrient Uptake (Kg/fed) / Nutrient Applied (Kg/fed)
2- Utilization efficiency = Dry weight (Kg/fed) / Nutrient Uptake (Kg/fed)
3- Fertilizer Recovery % = Use efficiency x 100

The obtained data were statistically analyzed using COSTAT program and L.S.D. value at the probability levels of 5% according to [12].

Results and Discussions

Yield parameters

It is clear that there were significant differences between alfalfa cultivars in all investigated traits (Table 2). The data also appear that , Nubaria cultivar gained the highest values in fresh, dry forage and crude protein yield and recorded values of (3.575, 0.664 and 0.113 ton / fed, followed by Liuji cultivar (2.363 , 0.507 and 0.102 ton / fed) for the same traits, respectively. While, Chaoyinsu cultivar characterized by the lowest values in that traits where recorded values of 1.070, 0.226 and 0.040 ton / fed, respectively. These could be attributing to the different genotypic characteristics of the tested cultivars and it also appears that adaptable cultivars for specific conditions should be recommended for proper regions.

This result confirms the variable response of alfalfa cultivars to the Nubaria environmental conditions. The statements of [13, 14 , 6,15, 16 ,17]confirmed our results.

Table 2: Means performance of fresh, dry forage yield and crude protein yield of five alfalfa cultivars for first forage cut in sandy soil under sprinkler irrigation system.

Cultivars	(Ton / Fed)		
	Fresh forage yield	Dry forage yield	Crude protein yield
Nubaria	3.575	0.664	0.113
Chaoyinsu	1.070	0.226	0.040
Juneng	1.971	0.450	0.077
Liuji	2.363	0.507	0.102
Runbulexin	1.134	0.291	0.050
LSD (0.05)	**0.079**	**0.014**	**0.030**

Table 3: Means concentration of macro, micronutrients and protein in shoot dry matter of five alfalfa cultivars for first forage cut in sandy soil under sprinkler irrigation system.

Cultivars	Use efficiency (nutrient uptake / Kg nutrient applied)			Utilization efficiency (dry weight (Kg/fed) / nutrient uptake (Kg/fed))			Fertilizer Recovery% (use efficiency x 100)		
	N	P	K	N	P	K	N	P	K
Nubaria	0.55	0.07	0.44	36.5	391	59.8	55	7	44
Chaoyinsu	0.19	0.02	0.15	35.9	450	59.5	19	2	15
Juneng	0.37	0.04	0.51	36.6	452	35.2	37	4	51
Liuji	0.50	0.06	0.43	30.9	390	47.4	50	6	43
Runbulexin	0.24	0.03	0.23	36.8	485	51.1	24	3	23
Mean	0.37	0.04	0.35	35.34	433.6	50.60	37.00	4.40	35.20

Chemical compositions of five alfalfa cultivars for first forage cut

With respect to minerals concentration of shoot forage, the data in Table (3) indicate that there are differences among the five tested cultivars. However, Liuji cultivar ranked first (3.233 and 20.2%) followed by Chaoyinsu cultivar (2.800 and 17.50%) for N and protein concentration, respectively. A similar trend was observed with P concentration Liuji cultivar (0.260%) where obtained the highest value comparing with the other cultivars. Regarding K concentration Juneng cultivar posed the highest value (2.833%) by Liuji cultivar (2.100%).Data also showed that Fe concentration varied between cultivars in the following order: Chaoyinsu›Runbulexin › Juneng › Liuji ›Nubaria. In the other hand, the values of Mn concentrations were about the same for and Liuji cultivars (46.02 and 46.30 ppm, respectively). But Chaoyinsu cultivar had the lowest Mn concentration (31.31ppm). Whereas, Juneng cultivar gained the highest result of Zn concentration (31.33ppm) followed by Liuji cultivar (26.33 ppm). Concerning Cu concentration, data also revealed that the highest value was observed with Liuji cultivar (15.33 ppm) followed by Juneng cultivar (14.00 ppm).

Also, it is important to notice that Liuji cultivar had higher all nutritive values under study compared with the other cultivars except for K, Fe and Zn concentration .However, Nubaria cultivar had the lowest all nutritive values comparing with the other cultivars for K,Fe and Cu concentrations.

These results are in agreement with those reported by[6,18,19] which stated a wide variation between verities. On the other hand,[20] mentioned that the minerals concentrations of plants depend on four factors: cultivar, soil environment, climate and stage of plant maturity.

Table 4: Means uptake of macro and micronutrient in shoot of five alfalfa cultivars for first cut in sandy soil under sprinkler irrigation system.

Cultivars	(%)				(ppm)			
	N	protein	P	K	Fe	Mn	Zn	Cu
Nubaria	2.733	17.03	0.250	1.667	417	46.02	22.67	9.00
Chaoyinsu	2.800	17.50	0.207	1.700	863	31.31	19.33	10.67
Juneng	2.733	17.10	0.230	2.833	782	34.32	31.33	14.00
Liuji	3.233	20.20	0.260	2.100	745	46.30	26.33	15.33
Runbulexin	2.733	17.10	0.220	1.967	846	44.71	23.67	11.67
LSD (0.05)	**0.363**	**2.22**	**0.029**	**0.138**	**51.0**	**6.42**	**2.06**	**2.99**

With regard to macro and micronutrient uptake by shoots, data recorded in (Table 4) pointed out a widely variation between the alfalfa cultivars from the two different geographic regions; Egypt and China. The highest values were mostly found with the variety of Egyptian origin, and the lowest one were the Chinese varieties. In this respect , N, P, K, Fe, Mn, Zn and Cu uptake were varied from (6.3 to 18.2 Kg N / fed), (0.5 to 1.7 Kg P / fed), (3.8 to 12.8 Kg K / fed), (195.0 to 377.7 g Fe / fed), (7.1 to 30.6 g Mn/ fed), (4.4 to 15.1 g Zn / fed) and (2.4 to 7.8 g Cu / fed) . In addition, the maximum N, P, Mn and Zn uptake were found with Nubaria cultivar followed by Liuji cultivar. However, Chaoyinsu cultivar having lower uptake from all elements compared with other cultivars under study.

On the other hand, Juneng cultivar had the highest uptake from K (12.8 Kg/ fed), whereas Liuji cultivar had maximum uptake from Fe and Cu(377.7and7.8g/fed),respectively compared with other cultivars. Similar results about variation along different varieties were reported by [21, 22, 23].

In this connection[24,25 ,26] indicated that some plant species and varieties adapt better to unfavorable soil condition than other, as well as there are big differences among varieties in their nutrient requirements. Concerning nutrient use efficiency, it is worthy to observe in Table (5) that uses efficiency, utilization efficiency and fertilizer recovery were different among cultivars. The highest recorded values of N and P use efficiency (0.55 and 0.07, respectively) were obtained by Nubaria cultivar, whereas the opposite was true with Chaoyinsu cultivar (0.19 and 0.02, respectively). Regarding K use efficiency it was found that the Juneng cultivar having the highest value (0.51) followed by Nubaria cultivar (0.44) but the lowest value of K use efficiency was obtained by Chaoyinsu cultivar (0.15). On the other hand, data revealed that Runbulexin cultivar was superior with N and P utilization efficiency (36.8 and 485, respectively).

While the lowest recorded values of N and P utilization efficiency were 30.9 and 390 for Liuji cultivar, respectively. Results of K utilization efficiency indicated that Nubaria cultivar post the highest value (59.8) as compared with other cultivars. On the other hand, data in Table (5) showed that the highest values of N and P fertilizer recovery were occurred by Nubaria cultivar (55% and 7 %, respectively). While, the highest recorded values of K fertilizer recovery was obtained by Juneng cultivar (51%) followed by Nubaria cultivar (44%) but the lowest recorded value was obtained by Chaoyinsu cultivar (15%). Similar variation results were obtained by other researchers; [27,28, 29 , 30 , 31,32]who found differences among cultivars in nutrient use efficiency such as use efficiency ,utilization efficiency and fertilizer recovery may be attributed to genetic factors responsible for higher or lower nutrient uptake, translocation and use efficiencies which different among cultivars.

Table 5: Means performance of N, P and K use efficiency, utilization efficiency and fertilizer recovery of five alfalfa cultivars for first cut in sandy soil under sprinkler irrigation system.

Cultivars	Use efficiency (nutrient uptake / Kg nutrient applied)			Utilization efficiency (dry weight (Kg/fed) / nutrient uptake (Kg/fed))			Fertilizer Recovery% (use efficiency x 100)		
	N	P	K	N	P	K	N	P	K
Nubaria	0.55	0.07	0.44	36.5	391	59.8	55	7	44
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Runbulexin	0.24	0.03	0.23	36.8	485	51.1	24	3	23
Mean	0.37	0.04	0.35	35.34	433.6	50.60	37.00	4.40	35.20

Conclusion

The above mentioned results indicate that alfalfa cultivars differ significantly with respect to all investigated traits. Nubaria Egyptian cultivar recorded higher values than other cultivars, especially for the most effective's traits. This evaluation is certainly important for better an agricultural valorization of this leguminous plant in the Egypt.

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