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Productivity of some forage grasses under foliar sprinkler irrigation and foliar application of potassium nitrate under salinity stress

A.A. Kandil, A.E. Shareif*

Department of Agronomy, Mansoura University, Egypt

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Key words: Alfalfa, Rhodes and Blue panic, Potassium nitrate, water use efficiency.

Abstract

Field experiment was conducted during 2013/2014 and 2015 seasons was aimed to evaluate productivity of Rhodes and Blue panic grasses as well as Alfalfa under sprinkler irrigation with foliar application of potassium nitrate that enable plants to cope with water stress. Each two forage grasses beside alfalfa were conducted in separate experiments**.** Irrigation every 10 days surpassed in total chlorophyll, leaf area, plant height, number of stems/m², forage green yield/fed and forage dry matter yield/fed than those irrigated every 20 days. Highest percentages of water use efficiency, crude fiber and nitrogen free extract as well as yield/fed of crude protein, crude fiber, ether extract, ash and nitrogen free extract were produced from irrigation every 7 days. However, highest percentages of crude protein, ether extract and ash were produced from irrigation every 14 days. Forage species significantly differed on total chlorophyll, leaf area/plant, plant height, average of number of stem/cm², forage green yield/fed and forage dry matter yield/fed. A significant effect due to forage species on percentages of water use efficiency, crude protein and fiber, extracting ether, ash and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed. Sown Rhodes grass produced maximum forage green and forage dry matter yield/fed and its quality compared with other studied forage crops. Foliar spraying of potassium nitrate at 15 ppm significantly increased total chlorophyll, leaf area, plant height, number of stems/m², forage green and forage dry matter yield/fed. The results showed that highest percentages of water use efficiency, crude protein, crude fiber and ether extract, and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed. It could be stated that irrigation every 10 days and sown Rhodes grass and foliar spraying of potassium nitrate at 15 ppm maximized forage green and forage dry matter yield/fed.

* **Corresponding Author:** Shareif AE ✉ shariefali42@gmail.com

Introduction

Alfalfa is the main forage crop in newly reclaimed soil in Egypt. In arid land, especially in Egypt, irrigation water is very limited and recently, the salinity soils and waste water were increased. Water is the single most limiting resource for world agriculture and food production, highly exceeding other key limitations. Efficient water use by irrigation systems is becoming increasingly important, especially, in arid and semi-arid regions with limited water sources. In agricultural practice, the sufficient and balanced application of irrigation water and nutrients are important methodology to obtain maximum yield per unit area. Several investigators studied the effect of irrigation water amounts or levels on some important plant characters. Large amount of water is used in field production of food crops, leading to a deficit of fresh water resources in many arid or semi-arid areas in the world (Zhu, 2002). Al-Suhaibani (2006) reported that both 1st and 2nd cut yield was about 85% of the total obtained forage. Concerning effect for growing season and irrigation intervals on the forage yield, expanding irrigation interval from 3 to 7 and 11 days decreased the potential yield from 143.6 to 123 and 85.3 t/ha, respectively. Al-Soqeer and Al-Ghumaiz (2012) showed that a significant effect for cuts on forage dry matter yield. recent years freshwater shortages have led to restrictions on the use of drinking water for landscape irrigation and an increase in the use of low quality water sources such as waste-water and brackish water. They added that expanding irrigation interval decreased all agronomic characters. There was a stronger response in grasses species dry matter yield to irrigation treatment. (Thomas *et al.,* 2006). In addition, Abusuwar and Eldin (2013) pointed out that irrigation every other day resulted in a significantly higher plant density, higher number of leaves per plant and higher fresh and dry yields compared to the longer irrigation interval (irrigation every 6 days). Sarkar and Malik (2001) stated that foliar spray of KNO_3 at 0.50% during 50% flowering stage showed maximum values of pods/plant, length of pod, seeds/pod and 1000 seed weight; it was significantly superior to water spray and unsprayed control, but was on par with $Ca(NO3)_2$ at 0.406%. Al-Soqeer and Al-Ghumaiz (2012) showed that there was a stronger response in grasses species dry matter yield to irrigation treatment. Rhodes grass had superior performance for all agronomic character comparing with other genotypes. Moosavi *et al.* (2012) showed that the 5 days irrigation interval allocated to itself the highest vegetative growth, yield and more quality of forage but with respect to water limitation and intense need to forage in the region, in order to scrounge in the amount of consumption water in the level unit and increase of under cultivation lands, we can use 10 days irrigation interval for the planting of forage sorghum. Abusuwar and Eldin (2013) pointed out that the two grasses (Teff and Rhodes grass) were more drought tolerant than two legumes (alfalfa and Siratro) as they resulted in higher plant density, higher number of leaves and higher productivity under all treatments. Zeinab Mobarak *et al.* (2013) reported that foliar application of magnesium nitrate as foliar fertilization has positively affected growth and development of maize plants through increasing concentration and uptake of macro and micronutrients by the plant tissues. Moreover, Osman *et al.* (2014) concluded that Rhodes grass significantly out yielded forage in all cuts other than the first one. Ali *et al.* (2007) stated that temporal prediction of soil moisture and evapotranspiration (ET) plays a crucial role in irrigation water management. Mirdad *et al.* (2009) indicated that the main effects of each irrigation dates (every 2, 4, 6 and 8 days) significantly differed vegetative growth and yield characters. Akram and Ashraf (2009) concluded that exogenous application of potassium nitrate increased the photosynthetic rate and leaf turgor which in turn resulted enhanced growth and yield in sunflower plants subjected to salt stress. Foliar application of KNO_3 was found to increase nitrate content of ryegrass leaves under non-saline or saline condition (Tabatabaei and Fakhrzad, 2008). Jabeen and Ahmed (2011) found that application of KNO_3 significantly reduced the increasing tendency of Na^+ and Cl^- and increased leaf area, its fresh and dry weight per plant, NO_3^- and soluble protein concentration and NR activity in leaves irrespective to the growth of plant

under non saline or saline conditions. Furthermore, conditions. Whereas, Gimeno *et al.* (2014) concluded that a 2% foliar KNO_3 application can enhance the tolerance of citrus plants to water stress by increasing the osmotic adjustment process. Therefore, the objective of this investigation was aimed to introduce forage grasses tolerant to water stress in new reclaimed soils to overcome the shortage in summer forage production in Egypt.

Materials and methods

Experimental treatments

Three separate experiments carried out for the two forage grasses beside alfalfa. This experiment aimed to evaluate productivity of studied forage grasses under normal of sprinkler irrigation with foliar application of potassium nitrate which play adaptive roles in plant stress tolerance. Each experiment included two treatments of irrigation.

1. Irrigation every 10 days or 20 days. Plastic sheet put in soil horizontally at depth 100 cm between irrigation treatments to prevent irrigation water movement.

2. Foliar application of potassium nitrate affects the tolerance of salinity of some forage i.e. foliar spraying of potassium nitrate i.e. 0, 5, 10 and 15 mg/L were applied as foliar spray after three weeks of each cut. The experiment was laid out in split plot design with four replications. The three grasses Rhodes grass (*Chloris gayana*, Kunth), Blue grass (*Panicum antidotale*, Retz.), and Alfalfa (*Medicago sativa*, L.) assigned in three separate experiments. The two sprinkler water irrigation every 10 days or 20 days occupied main plots. The sub plot treatment was allocated with four rates of foliar spraying of potassium nitrate i.e. 0, 5, 10 and 15 mg/L.

Studied Character

The following data were collected in each cut in the three experiments

Total chlorophyll (SPAD): Total chlorophyll (SPAD): Chlorophyll content in leaves samples was assessed by SPAD-502 (Minolta Co. Ltd., Osaka, Japan).

Number of stems per/m^2: Number of stems per plant counted per sample i.e. 0.25 m^2 and then transferred to number of stems/m^2.

Plant height (cm): Ten stems was taken at random from each plot. Stem length was measured from base of stem till its end.

Leaf area/plant in cm^2 was measured using Field Portable Leaf Area Meter AM-300 (Bio-Scientific, Ltd., Great Am well, Herefordshire, England).

Forage green yield per faddan: Two random samples taken using a square wooden frame 100×100 cm from each plot. Samples cut by sickle at about 3 cm height from soil surface and then weighted. Mean weight per square meter calculated then transformed as forage yield/feddan.

Forage dry matter yield/feddan: Two random samples of known weight (100 gm) taken from each plot. These samples dried at 70 0 C for 24 hr and then at 105 0 C till reached a constant weight. The dry matter yield/ feddan calculated using the following equation:

Dry matter yield/feddan = (Green yield per feddan) × (known weight of dry sample) ÷ (known weight of green sample).

Water use efficiency (WUE): Water use efficiency (kg/m^3) according to Wright, 1988. The consumed water (m^3/ha) was estimated as follows:

Consumed Water (m^3/ha) = (Moisture percentage in field capacity- soil moisture percentage) × root depth × Soil bulk density (1.76) × 10000

$$\textbf{WUE} = \frac{Total\ \ yield\ \ (kg/ha)}{Consumed\ \ water\ \ (m^3/ha)}$$

Where: WUE is Water use efficiency.

Chemical analysis

Crude protein (CP): The wet ash will have prepared and nitrogen be determined calorimetrically in the

acid digest using the method recommended by Koch and McMeekin (1924). Then crude protein percent was calculated by multiplying total nitrogen percent × 6.25 as described by Bolton and McCarthy (1962). Moreover, crude protein in Kg/faddan was calculated by multiplying crude protein percent × dry matter yield in Kg/faddan.

Ether extract (EE): Soxhelt apparatus will be used for determination of ether extract percent, heating by electric heater; cold water at 80° C was used through the condenser Ethyl ether that preferred for extraction which continued for not less than 8 hrs. (rate of siphoning is six per hr.) These methods are recommended by official and tentative methods of A.O.A.C. (2000). Moreover, ether extract in Kg/faddan was calculated by multiplying ether extract percent X yield of dry matter in Kg/faddan.

Crude fiber (CF): The usual weaned method was used for determination of fiber percent; boiling for 30 min took place in a suitable beaker under reflux. Filter medium is a suitable filter paper (corrugated and both acid and alkali resistant) be fitted into suitable Buckner flask attached to vacuum pump. Final washing after NaOH treatment was hot water, 5% HCl, hot water, alcohol and ether. Suction will be continued till almost dry, then the residue was quantitatively transformed out of the filter paper into a suitable crucible by gentle tapping and using a suitable brush. Drying at 105° C before ashing in the usually way. Moreover, crude fiber in Kg/faddan was calculated by multiplying crude fiber percent × yield of dry matter in Kg/faddan.

Ash content: A 5 grams of dry matter was burned in a muffle furnace at 600° C for four hrs. and then ash percent will be calculated. Moreover, ash in Kg/faddan was calculated by multiplying ash content × yield of dry matter in Kg/faddan.

Nitrogen free extracts (NFE): It was calculated by using the following equation: Nitrogen free extract = 100 – (crude protein percent + crude fiber percent + ether extract percent + ash percent). Then, amounts per faddan was calculated by multiplying nitrogen free extract × yield of dry matter in Kg/faddan.

Statistical analysis:

A combined analysis between the three studied forage crops was done to obtain the main effect of the three forage crops. In 2013/2014 season green fodder three cuts and dry matter analysis was carried out. Data was subjected to statistical analysis and means compare using LSD test at 5% level according to Gomez and Gomez (1991). The data were analyzed statistically following RCBD design by MSTAT-C computer package developed by Russel (1986).

Results and discussion

Cutting effects

The results presented in Table (1) showed that means of total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green yield/fed and forage dry matter yield/fed as affected by cuttings, irrigation intervals, forage species and proline concentrations foliar application. The results clearly showed that cuttings insignificantly affected total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green yield/fed and forage dry matter yield/fed. Concerning to chemical dry forage composition, the results presented in Tables (2 and 3) clearly showed insignificant effect due to cuttings on percentages of water use efficiency crude protein and fiber, extracting ether, ash and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons.

Irrigation intervals effect

The results in Table (1) showed that irrigation intervals significantly affected total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green yield/fed and forage dry matter yield/fed. The results indicated that irrigation every 10 days surpassed in total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green yield/fed and forage dry matter yield/fed than those irrigated every 20 days. The corresponding results were 16.09, 20.79, 67.04, 318.6, 3.311 and

2.052, respectively. The lowest values of total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green yield/fed and forage dry matter yield/fed were produced from irrigation every 20 days, which were 13.01, 12.41, 33.05, 158.1, 0.998 and 0.628, respectively. Al-Suhaibani (2006) reported that a significant effect for growing season and irrigation intervals on the forage yield, expanding irrigation interval from 3 to 7 and 11 days decreased the potential yield from 143.6 to 123 and 85.3 t/ha, respectively. Al-Soqeer and Al-Ghumaiz (2012) showed that expanding irrigation interval decreased all agronomic characters. There was a stronger response in grasses species dry matter yield to irrigation treatment. Abusuwar and Eldin (2013) found that irrigation every other day resulted in a significantly higher plant density, higher number of leaves per plant and higher fresh and dry yields compared to the longer irrigation interval (irrigation every 6 days).

With respect to results presented in Tables (2 and 3) results clearly indicated a significant effect due to irrigation intervals on percentages of water use efficiency crude protein and fiber, extracting ether, ash and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. Highest percentages of water use efficiency, crude fiber and nitrogen free extract as well as yield/fed of crude protein, crude fiber, ether extract, ash and nitrogen free extract were produced from irrigation every 7 days. However, highest percentages of crude protein, ether extract and ash were produced from irrigation every 14 days.

Table 1. Means of total chlorophyll (SPAD), leaf area (cm2), plant height (cm), number of stems/m2, forage green yield/fed and forage dry matter yield/fed as affected by cuttings, irrigation treatments, forage species, nitrate potassium concentrations and their interactions of three cuts during 2013/2014 and 2015 seasons.

Characters Treatments	Total chlorophyll (SPAD)	leaf area/plant (cm^2)	Plant height (cm)	Number of stems/m^2	Forage green yield t/fed	Dry matter yield t/fed
C- Cutting effects						
1st cut	14.57	16.55	50.25	236.7	2.066	1.287
2nd cut	14.40	16.66	50.03	237.7	2.148	1.355
3rd cut	14.27	16.33	49.63	237.9	2.178	1.342
4th cut	14.64	16.72	50.12	239.4	2.186	1.354
5th cut	14.87	16.73	50.19	240.1	2.194	1.361
LSD at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
I-Irrigation intervals						
Every 10 days	16.09	20.79	67.04	318.6	3.311	2.052
Every 20 days	13.01	12.41	33.05	158.1	0.998	0.628
F- Test at 5 %	*	*	*	*	*	*
F-Test C × I	*	NS	*	NS	N.S.	*
F Forage species						
Alfalfa	15.72	13.40	37.94	132.0	1.141	0.756
Rhodes grass	14.80	20.59	65.97	340.6	3.117	1.913
Blue panic grass	13.14	15.80	46.23	242.3	2.207	1.351
LSD at 5 %	0.13	0.05	0.35	0.16	0.031	0.054
F- Test C×F	NS	NS	NS	NS	*	*
I × F	*	*	*	*	*	*
C×I× F	NS	NS	NS	NS	*	N.S.

Characters Treatments	Total chlorophyll (SPAD)	leaf area/plant (cm²)	Plant height (cm)	Number of stems/m²	Forage green yield t/fed	Dry matter yield t/fed
N-Nitrate Potassium						
0 ppm	13.91	15.89	49.01	233.6	2.076	1.281
10 ppm	14.44	16.53	50.11	239.2	2.161	1.330
15 ppm	14.89	17.39	51.03	242.2	2.228	1.410
LSD at 5 %	0.11	0.15	0.32	0.16	0.032	0.054
C × N	NS	NS	NS	NS	*	N.S.
I × N	*	*	*	*	*	*
F × N	NS	NS	NS	NS	N.S.	*
C × F × N	NS	NS	NS	NS	NS	NS
C × I × N	NS	NS	NS	NS	*	NS
I × F × N	NS	NS	NS	NS	NS	NS
C × I× F × N	NS	NS	NS	NS	NS	NS

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Table 2. Percentages of Water Use Efficiency, Crude Protein, Crude Fiber, Ether Extract, Ash and Nitrogen free extract as affected by cuttings, irrigation treatments, forage species, nitrate potassium concentrations and their interactions of three cuts during 2013/2014 and 2015 seasons.

Treatments	Water Use Efficiency WUE%	Crude Protein %	Crude Fiber %	Ether Extract %	Ash content %	Nitrogen free extract %
C- Cutting effects						
1st cut	2.27	14.66	24.09	2.05	11.22	47.95
2nd cut	2.32	14.65	24.04	2.08	11.31	48.07
3rd cut	2.35	14.65	24.02	2.06	11.25	48.27
4th cut	2.40	14.73	24.08	2.06	11.26	48.11
5th cut	2.41	14.53	24.11	2.10	11.27	48.06
LSD at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
I-Irrigation intervals						
Every 10 days	3.59	14.47	23.63	2.03	11.20	48.56
Every 20 days	1.11	14.82	24.51	2.12	11.32	47.63
F-Test at 5 %	*	*	*	*	*	*
F-Test C×I	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F Forage species						
Alfalfa	1.28	19.12	16.74	2.38	12.82	49.19
Rhodes grass	3.40	11.36	25.55	2.15	10.54	50.22
Blue panic grass	2.36	13.45	29.91	1.69	10.43	44.87
LSD at 5 %	0.05	0.14	0.12	0.05	0.11	0.14
F- Test C × F	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F- Test I × F	*	*	*	*	*	*
F- Test C × I× F	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
N-Nitrate Potassium						
0 ppm	2.27	14.30	23.58	1.95	10.79	49.29
10 ppm	2.36	14.64	24.08	2.07	11.24	48.16
15 ppm	2.41	14.99	24.54	2.19	11.76	46.83
LSD at 5 %	0.04	0.12	0.09	0.05	0.07	0.45
C × N	NS	NS	NS	NS	N.S.	N.S.
I × N	NS	NS	NS	NS	NS	NS
F × N	*	NS	*	NS	*	N.S.
C × F × N	NS	NS	NS	NS	NS	NS
C × I × N	NS	NS	NS	NS	NS	NS
I × F × N	NS	NS	NS	NS	NS	NS
C × I× F × N	NS	NS	NS	NS	NS	NS

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Table 3. Means of Crude Protein, Crude Fiber, Ether Extract, Ash and Nitrogen free extract yield/fed as affected by cuttings, irrigation treatments, forage species, nitrate potassium concentrations and their interactions of three cuts during 2013/2014 and 2015 seasons.

Treatments	Crude Protein Yield Kg/fed	Crude Fiber Yield Kg/fed	Ether Extract Yield Kg/fed	Ash content yield Kg/fed	Nitrogen free extract yield Kg/fed
C- Cutting effects					
1st cut	172.9	322.5	24.8	140.5	623.6
2nd cut	177.1	328.8	26.7	143.9	625.9
3rd cut	179.8	336.2	26.8	145.5	654.2
4th cut	184.3	341.1	27.1	143.2	659.9
5th cut	182.1	341.7	27.6	148.7	662.6
LSD at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.
I-Irrigation intervals					
Every 10 days	274.0	205.8	40.0	222.2	992.4
Every 20 days	84.5	162.4	13.3	68.6	298.2
F-Test at 5 %	*	*	*	*	*
F-Test C × I	N.S.	N.S.	N.S.	N.S.	N.S.
F Forage species					
Alfalfa	143.3	124.3	18.1	97.0	773.0
Rhodes grass	216.4	482.2	40.0	200.9	970.7
Blue panic grass	178.0	395.7	21.8	138.3	592.1
LSD at 5 %	4.1	6.5	1.9	2.9	23.0
F- Test C× F	N.S.	N.S.	N.S.	N.S.	N.S.
I × F	*	*	*	*	*
C × I× F	N.S.	N.S.	N.S.	N.S.	N.S.
N-Nitrate Potassium					
0 ppm	167.9	316.2	24.4	133.9	636.7
10 ppm	178.6	333.0	26.2	145.0	643.7
15 ppm	191.2	353.1	29.3	157.2	655.4
LSD at 5 %	2.9	4.8	1.7	2.4	8.0
C × N	NS	NS	NS	N.S.	N.S.
I × N	NS	NS	NS	NS	NS
F × N	*	*	NS	*	N.S.
C× F × N	NS	NS	NS	NS	NS
C × I × N	NS	NS	NS	NS	NS
I × F × N	NS	NS	NS	NS	NS
C × I × F × N	NS	NS	NS	NS	NS

N. S.= Not significant, *= significant at 5%, **= significant at 1%.

Interaction between cuttings and irrigation intervals effect

Regarding the interaction between cuttings and irrigation intervals on total chlorophyll (SPAD), the results indicated that this interaction significantly affected total chlorophyll as shown in Table (4). The results indicated that the fifth cut and irrigation every 10 days recorded highest values of total chlorophyll without significant differences, which was 16.52. However, the lowest values of total chlorophyll were obtained from the third cut and irrigation every 20 days, which was 12.62.

With respect to the interaction effect between cuttings and irrigation intervals on leaf area/plant (cm^2), the results in Table (1) indicated that this interaction insignificantly affected leaf area/plant (cm^2).

Table 4. Averages of total chlorophyll (SPAD) as affected by the interaction between cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 10 days	Every 20 days
1st cut	15.84	13.31
2nd cut	15.92	12.89
3rd cut	15.92	12.62
4th cut	16.27	13.01
5th cut	16.52	13.23
LSD at 5 %	0.23	

Concerning to the interaction between cuttings and irrigation intervals on plant height, the results in Table (5), the results indicated that this interaction significantly affected plant height. The results revealed that the tallest plants were produced from the fourth or fifth cut and irrigation every 10 days without significant differences (67.5 cm). However, the shortest plants were obtained from the third cut and irrigation every 20 days, which was 32.4 cm.

Regarding the interaction effect between cuttings and irrigation intervals on number of stems/m^2, the results in Table (1) indicated that this interaction insignificantly affected number of stems/m^2.

Table 5. Means of plant height (cm) as affected by the interaction between cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 10 days	Every 20 days
1st cut	66.6	33.9
2nd cut	66.8	33.2
3rd cut	66.8	32.4
4th cut	67.5	32.8
5th cut	67.5	32.9
LSD at 5 %	0.6	

Concerning to the interaction between cuttings and irrigation intervals on fresh forage yield/fed, the results indicated that this interaction significantly affected forage green yield. The results in Table (6) clearly revealed that highest forage green yield/fed was produced from the fifth cut and irrigation every 10 days, which was 3.989 t/fed. However, the lowest forage green yield was obtained from the second cut and irrigation every 20 days, which was 0.993 t/fed, respectively.

Table 6. Averages of forage green yield (ton/fed) as affected by the interaction between cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 10 days	Every 20 days
1st cut	3.129	1.005
2nd cut	3.302	0.993
3rd cut	3.362	0.994
4th cut	3.373	0.999
5th cut	3.989	0.999
LSD at 5 %	0.007	

With respect to the interaction between cuttings and irrigation intervals on forage dry matter yield/fed, the results indicated that this interaction significantly affected forage dry matter yield/fed as shown in Table (7). The results revealed that highest forage dry matter yield/fed was produced from the fifth cut and irrigation every 10 days, which was 2.086 t/fed. However, the lowest forage dry matter yield/fed was obtained from the second or third cut and irrigation every 20 days without significant differences, which was 0.620 t/fed.

Regarding the interaction effect between cuttings and irrigation intervals on percentages of water use efficiency, crude protein and fiber, extracting ether, ash and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Table 7. Averages of forage dry matter yield (ton/fed) as affected by the interaction between cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 10 days	Every 20 days
1st cut	1.951	0.622
2nd cut	2.081	0.628
3rd cut	2.063	0.620
4th cut	2.078	0.630
5th cut	2.086	0.639
LSD at 5 %	0.010	

Forage species effect

The results in Table (1) clearly indicated that forage species significantly differed on total chlorophyll, leaf area/plant (cm^2), plant height (cm), average of number of stem/cm^2, forage green yield/fed and forage dry matter yield/fed. Highest values of total chlorophyll was produced from sown alfalfa (15.72). However, the lowest values of total chlorophyll were produced from sown Blue panic grass (13.14). The results showed that Rhodes grass recorded highest values of leaf area/plant (cm^2), plant height (cm), average of number of stem/cm^2, forage green yield/fed and forage dry matter yield/fed. The corresponding data were 20.59, 65.97, 340.6, 3.117 and 1.913, respectively. However, the lowest values were obtained from sown alfalfa, which were 13.40, 37.94, 132.0, 1.141 and 0.756, respectively. Sarkar and Malik (2001) stated that foliar spray of KNO_3 at 0.50% during 50% flowering stage showed maximum values of pods/plant, length of pod, seeds/pod and 1000 seed weight; it was significantly superior to water spray and unsprayed control, but was on par with Ca $(NO_3)_2$ at 0.406%. Al-Soqeer and Al-Ghumaiz (2012) showed that there was a stronger response in grasses species dry matter yield to irrigation treatment. Rhodes grass had superior performance for all agronomic character comparing with other genotypes. Moosavi *et al.* (2012) showed that the 5 days irrigation interval allocated to itself the highest vegetative growth, yield and more quality of forage but with respect to water limitation and intense need to forage in the region, in order to scrounge in the amount of consumption water in the level unit and increase of under cultivation lands, we can use 10 days irrigation interval for the planting of forage sorghum. Abusuwar and Eldin (2013) pointed out that the two grasses (Teff and Rhodes grass) were more drought tolerant than two legumes (alfalfa and Siratro) as they resulted in higher plant density, higher number of leaves and higher productivity under all treatments. Zeinab Mobarak *et al.* (2013) reported that foliar application of magnesium nitrate as foliar fertilization has positively affected growth and development of maize plants through increasing concentration and uptake of macro and micronutrients by the plant tissues. Recently, Osman *et al.* (2014) concluded that Rhodes grass significantly out yielded forage in all cuts other than the first one.

Regarding to results presented in Tables (2 and 3) results clearly indicated a significant effect due to forage species on percentages of water use efficiency, crude protein and fiber, extracting ether, ash and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. Highest percentages of water use efficiency, and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed sown Rhodes grass during 2013/2014 and 2015 seasons were obtained from. The corresponding data were 3.40, 50.22% and 216.4, 482.2, 40.0, 200.9 and 970.7 Kg/fed, respectively. Highest percentages of crude protein, extracting ether and ash percentages from sown Alfalfa during 2013/2014 and 2015 seasons. The corresponding data were 19.12, 2.38 and 12.82%, respectively. Efficient use of water resources can be made possible through the assessment of crop water requirements and proper scheduling of irrigation. Hashim *et al.* (2012) determined the water requirements and crop water productivity of different seasonal and forage crops cultivated in the Makkah region of Saudi Arabia and concluded that in forage crops, the water requirements varied from 962.75 mm in Sudan grass to 1922.50 mm in alfalfa. The total crop water consumption (mm) was highest in alfalfa (1922.50) followed by Rhodes grass (1821.94), blue

panic grass (1287.76) and Sudan grass (962.75). Blue panic grass can be recommended for cultivation as a forage crop. Kamel *et al.* (2012) demonstrated that optimal irrigation scheduling requires accurate estimates of crop evapotranspiration. Whereas, Sir and Ahmed (2014) reported that the shorter irrigation intervals (7 and 14 day) were statistically significant over the longer interval (21days).

Interaction between cuttings and forage species effect

With respect to the interaction effect between cuttings and forage species on total chlorophyll, leaf area/plant (cm^2), plant height (cm) and average number of stem/cm^2, the results in Table (1) showed insignificant effected on total chlorophyll, leaf area/plant (cm^2), plant height (cm) and average number of stem/cm^2.

Regarding to the interaction effect between cuttings and forage species on forage green yield/fed, the results in Table (8) clearly indicated this interaction significantly affected forage green yield/fed. The results showed that highest forage green yield/fed was produced from the fifth cut and sowing Rhodes grass (3.160 t/fed). On contrary, the lowest forage green yield/fed was recorded from the first cut of alfalfa (1.066 t/fed).

Table 8. Means of forage green yield ton/fed as affected by the interaction between cuttings and forage species during 2013/2014 and 2015 seasons.

Cuttings	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
1st cut	1.066	3.020	2.115
2nd cut	1.149	3.108	2.187
3rd cut	1.157	3.142	2.235
4th cut	1.163	3.153	2.243
5th cut	1.170	3.160	2.252
LSD at 5 %	0.070		

Concerning the interaction between cuttings and forage species on forage dry matter yield/fed, the results in Table (9) clearly indicated that this interaction significantly affected forage dry matter yield/fed. The results revealed that highest forage dry matter yield/fed was obtained from the fifth cut and sown Rhodes grass, which were 1.953 t/fed. On contrary, the lowest forage dry matter yield/fed was recorded from the first cut and sowing alfalfa, which was 0.718 t/fed.

With respect to the interaction effect between cuttings and irrigation intervals on percentages of water use efficiency, crude protein and fiber, extracting ether, ash and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Table 9. Means of forage dry matter yield (ton/fed) as affected by the interaction among cuttings and forage plant species during 2013/2014 and 2015 seasons.

Cuttings	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
1st cut	0.718	1.863	1.281
2nd cut	0.758	1.888	1.418
3rd cut	0.761	1.921	1.343
4th cut	0.769	1.940	1.353
5th cut	0.774	1.953	1.362
LSD at 5 %	0.012		

Interaction between irrigation intervals and forage species effect

Regarding to the interaction between irrigation treatments and forage plant species on total chlorophyll (SPAD), the results in Table (10) clearly showed that this interaction significantly affected total chlorophyll. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest values of total chlorophyll, which was 17.07. While, the lowest values of total chlorophyll were produced from irrigation every 20 days and sowing Blue panic grass (11.67).

Table 10. Averages of total chlorophyll (SPAD) as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	16.60	17.07	14.61
Every 20 days	14.84	12.53	11.67
LSD at 5 %	0.18		

Concerning the interaction between irrigation intervals and forage species on leaf area/plant (cm^2), the results in Table (11) clearly showed that this interaction significantly affected leaf area/plant (cm^2). The results indicated that irrigation every 10 days and sowing Rhodes grass produced highest values of leaf area/plant (cm^2), which was 25.53 cm^2/plant. While, the lowest values of leaf area/plant (cm^2) was produced from irrigation every 20 days and sowing alfalfa (10.45 cm^2/ plant).

Table 11. Averages of leaf area/plant (cm2) as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	16.53	25.53	20.49
Every 20 days	10.45	15.66	11.12
LSD at 5 %	0.29		

Regarding the interaction effect between irrigation intervals and forage species on plant height, the results in Table (12) clearly showed that this interaction significantly affected plant height. The results showed that irrigation every 10 days and sowing Rhodes grass produced tallest plants (84.6 cm). While, the shortest plants were produced from irrigation every 20 days and sowing alfalfa (25.7 cm).

Table 12. Means of plant height (cm) as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	50.1	84.6	66.3
Every 20 days	25.7	47.3	26.2
LSD at 5 %	0.49		

With respect to the interaction effect between irrigation intervals and forage species on number of stems/m^2, the results in Table (13) clearly showed that this interaction significantly affected number of stems/m^2. The results indicated that irrigation every 10 days and sowing Rhodes grass produced highest number of stems/m^2, which was 450.0 stems/m^2. Whilst, the lowest number of stems/m^2 was produced from irrigation every 20 days and sowing alfalfa (107.0 stems/m^2).

Table 13. Averages of number of stem/m^2 as affected by the interaction between irrigation intervals and forage plant species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	155.5	450.0	349.3
Every 20 days	107.9	231.0	153.3
LSD at 5 %	0.7		

Regarding the interaction effect between irrigation intervals and forage species on forage green yield/fed, the results in Table (14) clearly showed that this interaction significantly affected forage green yield/fed. The results showed that irrigation every 10 days and sowing Rhodes grass produced highest forage green yield/fed, which was 4.645 t/fed. While, the lowest forage green yield/fed was obtained from irrigation every 20 days and sowing alfalfa (0.514 t/fed).

Table 14. Means of forage green yield (ton/fed) as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	1.768	4.645	3.520
Every 20 days	0.514	1.588	0.892
LSD at 5 %	0.044		

With respect to the interaction effect between irrigation intervals and forage species on forage dry matter yield/fed, the results in Table (15) clearly

showed that this interaction significantly affected forage dry matter yield/fed. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest forage dry matter yield/fed, which was 2.830 t/fed. While, the lowest forage dry matter yield/fed was produced from irrigation every 20 days and sowing alfalfa (0.316 t/fed).

Table 15. Average of forage dry matter yield (ton/fed) as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	1.196	2.830	2.131
Every 20 days	0.316	0.996	0.572
LSD at 5 %	0.077		

With respect to the interaction effect between irrigation intervals and forage species on water use efficiency, the results in Table (16) clearly indicated that this interaction significantly affected forage water use efficiency. The results revealed that irrigation every 10 days and sowing Alfalfa produced highest values of water use efficiency (4.49). While, the lowest forage dry matter yield/fed was produced from irrigation every 20 days and sowing alfalfa (1.06).

Table 16. Average of water use efficiency as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	4.49	3.60	3.67
Every 20 days	1.06	1.11	1.16
LSD at 5 %	0.04		

Regarding to the interaction effect between irrigation intervals and forage species on crude protein percentage, the results in Table (17) clearly showed that this interaction significantly affected crude protein percentage. The results revealed that irrigation every 20 days and sowing Alfalfa produced highest crude protein percentage (19.41%). which was 2.792 t/fed. While, the lowest crude protein percentage was produced from irrigation every 10 days and sowing Rhodes grass (11.22%).

Table 17. Average of crude protein percentage as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	18.83	11.22	13.37
Every 20 days	.19.41	11.51	13.53
LSD at 5 %	0.21		

With respect to the interaction effect between irrigation intervals and crude fiber percentage, the results in Table (18) clearly showed that this interaction significantly affected crude fiber percentage. The results revealed that irrigation every 20 days and sowing Blue panic grass produced highest crude fiber percentage (30.09%). However, the lowest crude fiber percentage was produced from irrigation every 10 days and sowing alfalfa (16.42%).

Table 18. Average of crude fiber percentage as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	16.42	24.73	29.74
Every 20 days	17.07	26.36	30.09
LSD at 5 %	0.13		

Concerning to the interaction effect between irrigation intervals and forage species on ether extract, the results in Table (19) clearly showed that this interaction significantly affected ether extract. The results revealed that irrigation every 10 days and sowing Alfalfa produced highest ether extract (2.40%). While, the lowest ether extract was produced from irrigation every 10 days and sowing Blue panic grass (1.63%).

Table 19. Average of ether extract as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	2.40	2.07	1.63
Every 20 days	2.37	2.22	1.76
LSD at 5 %	0.06		

With respect to the interaction effect between irrigation intervals and forage species on ash percentage, the results in Table (20) clearly showed that this interaction significantly affected ash percentage. The results revealed that irrigation every 20 days and sowing Rhodes grass produced highest ash percentage Blue panic grass (1.63%). While, the lowest ash percentage was produced from irrigation every 20 days and sowing alfalfa (10.78%).

Table 20. Average of ash percentage as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	10.78	11.18	11.65
Every 20 days	10.81	11.31	11.87
LSD at 5 %	0.07		

Regarding to the interaction effect between irrigation intervals and forage species on nitrogen free extract percentage, the results in Table (21) clearly showed that this interaction significantly affected nitrogen free extract percentage. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest nitrogen free extract percentage (51.29%). While, the lowest forage dry matter yield/fed was produced from irrigation every 20 days and sowing alfalfa (44.79%).

Table 21. Average of nitrogen free extract percentage as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	49.44	51.29	44.95
Every 20 days	48.95	49.16	44.79
LSD at 5 %	0.60		

With respect to the interaction effect between irrigation intervals and forage species on crude protein yield/fed, the results in Table (22) clearly showed that this interaction significantly affected crude protein yield/fed. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest crude protein yield/fed, which was 318.2 Kg/fed. While, the lowest crude protein yield/fed was produced from irrigation every 20 days and sowing alfalfa (61.4 Kg/fed).

Concerning to the interaction effect between irrigation intervals and forage species on crude fiber yield/fed, the results in Table (23) clearly showed that this interaction significantly affected crude fiber yield/fed. The results discovered that irrigation every 10 days and sowing Rhodes grass produced highest crude fiber yield/fed, which was 701.8 Kg/fed. While, the lowest crude fiber yield/fed was produced from irrigation every 20 days and sowing alfalfa (52.1 Kg/fed).

Table 22. Average of crude protein yield/fed as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	225.2	318.2	278.6
Every 20 days	61.4	114.8	77.5
LSD at 5 %	5.8		

Table 23. Average crude fiber yield/fed as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	196.7	701.8	619.0
Every 20 days	52.1	262.7	172.4
LSD at 5 %	12.6		

Regarding to the interaction effect between irrigation intervals and forage species on ether extract yield/fed, the results in Table (24) clearly showed that this interaction significantly affected ether extract yield/fed. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest ether extract yield/fed, which was 57.3 Kg/fed. While, the lowest ether extract yield/fed was produced from irrigation every 20 days and sowing alfalfa (7.4 Kg/fed).

Table 24. Average of ether extract yield/fed as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	28.7	57.8	33.6
Every 20 days	7.4	22.3	10.0
LSD at 5 %	2.7		

With respect to the interaction effect between irrigation intervals and forage species on ash yield/fed, the results in Table (25) clearly showed that this interaction significantly affected ash yield/fed. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest ash yield/fed, which was 296.8 Kg/fed. While, the lowest ash yield/fed was produced from irrigation every 20 days and sowing alfalfa (40.6 Kg/fed).

Table 25. Average of ash yield/fed as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	153.4	296.8	216.4
Every 20 days	40.6	105.2	60.2
LSD at 5 %	4.2		

Regarding to the interaction effect between irrigation intervals and forage species on nitrogen free extract yield/fed, the results in Table (26) clearly showed that this interaction significantly affected nitrogen free extract yield/fed. The results revealed that irrigation every 10 days and sowing Rhodes grass produced highest nitrogen free extract yield/fed, which was 1457.0 Kg/fed. While, the lowest nitrogen free extract yield/fed was produced from irrigation every 20 days and sowing alfalfa (154.2 Kg/fed).

Interaction between cuttings, irrigation intervals and forage species effect

Concerning to the interaction effect between cuttings, irrigation intervals and forage species on total chlorophyll (SPAD), leaf area/plant (cm^2), plant height (cm) and number of stems/m^2, the results in Table (1) clearly showed that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2.

Regarding the interaction effect between cuttings, irrigation intervals and forage species on forage green yield/fed, the results in Table (27) clearly revealed that this interaction significantly affected forage green yield/fed. The results showed that highest forage green yield/fed was produced from the fifth cut of Rhodes grass when irrigated every 10 days, which was 4.735 t/fed. On contrary, the lowest forage green yield/fed was produced from the first cut and sowing alfalfa when irrigated every 20 days, which was 0.490 t/fed.

Table 26. Average of nitrogen free extract yield/fed as affected by the interaction between irrigation intervals and forage species, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
Every 10 days	501.9	1457.0	928.4
Every 20 days	154.2	484.6	255.9
LSD at 5 %	7.8		

With respect to the interaction effect between cuttings, irrigation intervals and forage species on forage dry matter yield/fed, the results in Table (1) clearly indicated that this interaction insignificantly affected forage dry matter yield/fed.

Regarding to the interaction effect between cuttings, irrigation intervals and forage species on percentages of water use efficiency, crude protein and fiber, ether extract, ash and nitrogen free extract as well as crude protein and fiber, ether extract, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Table 27. Averages of forage green yield (ton/fed) as affected by the interaction between cuttings, irrigation intervals and forage species during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals					
	Every 10 days			Every 20 days		
	Forage species			Forage species		
	Alfalfa	Rhodes grass	Blue panic grass	Alfalfa	Rhodes grass	Blue panic grass
1st cut	1.641	4.424	3.322	0.490	1.616	0.909
2nd cut	1.781	4.639	3.487	0.517	1.578	0.886
3rd cut	1.796	4.707	3.583	0.518	1.577	0.887
4th cut	1.803	4.722	3.596	0.523	1.585	0.890
5th cut	1.817	4.735	3.614	0.523	1.585	0.890
LSD at 5 %	0.099					

Potassium nitrate concentrations foliar application effect

With respect to effect of potassium nitrate concentrations foliar application on total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed., the results in Table (1) showed that foliar application of potassium nitrate at different concentrations significantly affected total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, fresh and dry forage yield ton/fed. The results showed that foliar spraying of potassium nitrate at 15 ppm significantly increased total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed. The corresponding data were 14.89, 17.39, 51.03, 242.2, 2.228 and 1.410, respectively. However, the lowest values of total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed were obtained from without potassium nitrate foliar spraying i.e. the control treatment, which were 13.91, 15.89, 49.01, 233.6, 2.076 and 1.281, respectively. Akram and Ashraf (2009) concluded that exogenous application of potassium nitrate increased the photosynthetic rate and leaf turgor which in turn resulted enhanced growth and yield in sunflower plants subjected to salt stress. Foliar application of KNO_3 was found to increase nitrate content of ryegrass leaves under non-saline or saline condition (Tabatabaei and Fakhrzad, 2008). Jabeen and Ahmed (2011) found that application of KNO3 significantly reduced the increasing tendency of Na^+ and Cl^- and increased leaf area, its fresh and dry weight per plant, NO_3^- and soluble protein concentration and NR activity in leaves irrespective to the growth of plant under non saline or saline conditions. Furthermore, conditions. Gimeno *et al.* (2014) concluded that a 2% foliar KNO_3 application can enhance the tolerance of citrus plants to water stress by increasing the osmotic adjustment process. High salt concentrations in the root zone causes adverse effects on plant. These salt effects may cause membrane disorganization, production of toxic metabolites and inhibition in photoshynsis leading to reduced growth of plants. Foliar fertilization can therefore be a complementary measure taken to provide nutrients during a critical phase of restricted nutrient supply. In This Respect, Kaya *et al.* (2007) found that exogenously applied potassium nitrate through the root zone significantly mitigated the adverse effects of salt stress on growth of melon. They added that the alleviating effects of potassium nitrate were attributed to maintenance of membrane permeability and enhanced concentrations of Ca^{2+}, N and K^+ in the leaves of salt stressed plants.

With respect to results presented in Tables (2 and 3) results clearly indicated a significant effect due to foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, extracting ether, ash and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during

2013/2014 and 2015 seasons. Highest percentages of water use efficiency, crude protein, crude fiber and ether extract, and nitrogen free extract and nitrogen free extract as well as crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. The correspond data were 2.41,14.99, 24.54, 2.19, 11.76 % as well as 191.2, 353.1, 29.3,157.2 and 655.4 Kg/fed, respectively during 2013/2014 and 2015 seasons. In addition, the lowest of above traits were produced from without foliar application of potassium nitrate during 2013/2014 and 2015 seasons. However highest percentages of nitrogen free extract (49.29%) was produced from without foliar application of potassium nitrate during 2013/2014 and 2015 seasons. Akram and Ashraf (2009) reported that exogenous application of KNo_3 can increased the photosynthetic rate and leaf turgor which in turn resulted in enhanced growth and yield in sunflower plants subjected to salt stress. Foliar applied KNO_3 increased leaf N and K^+ and regulated the opening and closing of stomata thereby maintaining plant water efficiency.

Interaction between cuttings and potassium nitrate concentrations foliar application effect

Concerning to the interaction effect between cuttings and potassium nitrate concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2, the results in Table (1) clearly indicated that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2.

Regarding the interaction effect between cuttings and potassium nitrate concentrations foliar application on forage green yield/fed, the results in Table (28) indicated that this interaction significantly affected forage green yield/fed. Highest forage green yield/fed was produced from the fifth cut and potassium nitrate foliar application at 15 ppm (2.269 t/fed). However, the lowest forage green yield/fed was produced from the first cut and without potassium nitrate foliar application (2.004 t/fed).

Table 28. Averages of forage green yield/fed as affected by the interaction between cuttings and potassium nitrate concentrations foliar spraying during 2013/2014 and 2015 seasons.

Cuttings	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
1st cut	2.004	2.065	2.131
2nd cut	2.061	2.154	2.229
3rd cut	2.098	2.186	2.250
4th cut	2.105	2.195	2.259
5th cut	2.110	2.203	2.269
LSD at 5 %		0.072	

Regarding the interaction effect between cuttings and potassium nitrate concentrations foliar application on forage dry matter yield/fed, the results in Table (1) indicated that this interaction insignificantly affected forage dry matter yield/fed.

With respect to the interaction effect between cuttings and foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, ether extract, ash and nitrogen free extract as well as crude protein and fiber, ether extract, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Interaction between irrigation intervals and potassium nitrate foliar application effect

Regarding the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on total chlorophyll, the results in Table (29) indicated that this interaction significantly affected total chlorophyll. Highest values of total chlorophyll were produced from irrigation every 10 days and potassium nitrate foliar application at 15 ppm (16.4). However, the lowest values of total chlorophyll were produced from irrigation every 20 days and without potassium nitrate foliar application (12.4).

Table 29. Averages of total chlorophyll as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	15.74	16.14	16.40
Every 20 days	12.40	12.98	13.97
LSD at 5 %	0.16		

Regarding the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on leaf area (cm²), the results in Table (30) indicated that this interaction significantly affected leaf area (cm²). Highest leaf area (cm²) was produced from irrigation every 7 days and potassium nitrate concentrations foliar application at 15 ppm (21.77 cm²/plant). However, the lowest leaf area/plant (cm²), was produced from irrigation every 20 days and without potassium nitrate foliar application (11.84 cm²/plant).

Table 30. Averages of leaf area as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	19.95	20.65	21.77
Every 20 days	11.84	12.40	13.00
LSD at 5 %	0.20		

With respect to the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on plant height (cm), the results in Table (31) indicated that this interaction significantly affected plant height. Tallest plants were produced from irrigation every 10 days and potassium nitrate foliar application at 15 ppm (68.1 cm). However, the shortest plants were produced from irrigation every 20 days and without potassium nitrate foliar application (32.3 cm).

Table 31. Means of plant height as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	65.8	67.2	68.1
Every 20 days	32.3	33.0	33.9
LSD at 5 %	0.45		

Concerning to the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on number of stem/m², the results in Table (32) indicated that this interaction significantly affected number of stem/m². Highest number of number of stem/m² was produced from irrigation every 10 days and potassium nitrate foliar application at 15 ppm (319.2 stems /m²). However, the lowest number of stem/m² was produced from irrigation every 20 days and without potassium nitrate foliar application (149.3 stems/m²).

Table 32. Averages of number of stem/m² as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	317.8	318.8	319.2
Every 20 days	149.3	159.8	165.2
LSD at 5 %	0.77		

Regarding the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on forage green yield/fed, the results in Table (33) indicated that this interaction significantly affected forage green yield/fed. Highest forage green yield/fed was produced from irrigation every 10 days and potassium nitrate foliar application at 15 ppm (3.431 t/fed). However, the lowest forage green yield/fed was produced from irrigation every 20 days and without potassium nitrate foliar application (0.969 t/fed).

Regarding the interaction effect between irrigation intervals and potassium nitrate concentrations foliar application on forage dry matter yield/fed, the results in Table (34) indicated that this interaction significantly affected forage dry matter yield/fed. Highest forage dry matter yield/fed was produced from irrigation every 10 days and potassium nitrate foliar application at 15 ppm (2.167 t/fed). However, the lowest forage dry matter yield/fed was produced from irrigation every 20 days and without potassium nitrate foliar application (0.605 t/fed).

Table 33. Averages of forage green yield (ton/fed) as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	3.183	3.320	3.431
Every 20 days	0.969	0.0011	1.024
LSD at 5 %		0.046	

Table 34. Averages of forage dry matter yield ton/fed as affected by the interaction between irrigation intervals and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Every 10 days	1.956	2.034	2.167
Every 20 days	0.605	0.626	0.653
LSD at 5 %		0.076	

With respect to the interaction effect between irrigation intervals and foliar application of potassium nitrate on percentages of crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Interaction between forage species and potassium nitrate concentrations foliar application effect

Concerning to the interaction effect between forage species and potassium nitrate concentrations foliar application on total chlorophyll, plant height (cm) and number of stems/m^2, the results in Table (1) clearly indicated that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2.

With respect to the interaction effect between forage species and potassium nitrate concentrations foliar application on forage green yield/fed the results in Table (35) indicated that this interaction significantly affected forage green yield/fed. The results showed that highest fresh forage yield/fed was obtained from planting Rhodes grass and potassium nitrate foliar application at 15 ppm (3.195 t/fed). However, the lowest forage green yield/fed was produced from planting alfalfa and without potassium nitrate foliar application (1.084 t/fed).

Table 35. Averages of forage green yield (ton/fed) as affected by the interaction between forage species and potassium nitrate concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm
Alfalfa	1.084	1.146	1.193
Rhodes grass	3.022	3.133	3.195
Blue panic grass	2.121	2.204	2.294
LSD at 5 %		0.056	

Regarding the interaction effect between forage species and potassium nitrate concentrations foliar application on forage dry matter yield/fed, the results in Table (1) indicated that this interaction insignificantly affected forage dry matter yield/fed.

With respect to the interaction effect between forage species and potassium nitrate concentrations foliar application on percentages of crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Interaction between cutting, irrigation intervals and potassium nitrate concentrations foliar application effect

Concerning to the interaction effect between cuttings, irrigation intervals and potassium nitrate concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2, the results in Table (1) clearly indicated that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm) and number of stems/m^2.

Regarding the interaction effect between cuttings, irrigation intervals and potassium nitrate concentrations foliar application on forage green yield/fed, the results in Table (36) indicated that this interaction significantly affected forage green yield/fed. The results revealed that highest forage green yield/fed was produced from the third cut and irrigation every 10 days and potassium nitrate foliar application at 15 ppm (3.520 t/fed). However, the lowest forage green yield/fed was obtained from the first cut and irrigation every 20 days and without potassium nitrate foliar application (0.962 t/fed).

Regarding the interaction effect between cuttings, irrigation intervals and potassium nitrate concentrations foliar application on forage dry matter yield/fed, the results in Table (1), the results indicated that this interaction insignificantly affected forage dry matter yield/fed.

Table 36. Averages of forage green yield (ton/fed) as affected by the interaction between cuttings, irrigation intervals and potassium nitrate concentrations during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals					
	Every 10 days			Every 20 days		
	Potassium nitrate concentrations			Potassium nitrate concentrations		
	0 ppm	10 ppm	15 ppm	0 ppm	10 ppm	15 ppm
1st cut	3.046	3.136	3.205	0.962	0.995	1.057
2nd cut	3.156	3.308	3.443	0.966	1.000	1.014
3rd cut	3.228	3.372	3.487	0.969	1.000	1.014
4th cut	3.237	3.385	3.499	0.973	1.006	1.019
5th cut	3.248	3.399	3.520	0.973	1.006	1.019
LSD at 5 %	0.011					

With respect to the interaction effect between cutting, irrigation intervals and foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons

Interaction between Cuttings, Forage Species and Potassium Nitrate Concentrations Foliar Application Effect

With respect to the interaction effect between cuttings, forage species and potassium nitrate concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed, the results in Table (1) clearly indicated that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed.

With respect to the interaction effect between cutting, forage species and foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Interaction between irrigation intervals, forage species and potassium nitrate concentrations foliar application effect

Regarding the interaction effect between irrigation intervals, forage species and potassium nitrate concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed, the results in Table (1) clearly indicated that

this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2) plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed.

With respect to the interaction effect between irrigation intervals, forage species and foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons

Interaction between cuttings, irrigation intervals, forage species and potassium nitrate concentrations foliar application effect

Regarding the interaction effect between cuttings, irrigation intervals, forage species and potassium nitrate concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed, the results in Table (1) clearly indicated that this interaction insignificantly affected total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, forage green and forage dry matter yield/fed.

With respect to the interaction effect between cutting, irrigation intervals, forage species and foliar application of potassium nitrate on percentages of water use efficiency, crude protein and fiber, ether extract and nitrogen free extract as well as crude protein and fiber, ether extract and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons, the results in Tables (2 and 3) indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

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