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PRODUCTIVITY OF SOME FORAGE GRASSES AND ALFALFA UNDER FOLIAR SPRINKLER IRRIGATION WITH FOLIAR APPLICATION OF CHEMICAL SUBSTANCES UNDER WATER STRESS

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Abstract

As regardsthesoil and water resources is limited, so we cultivate forage crops in new reclaimed soil with methods need low in water like foliar irrigation. Fieldexperiment was conducted during 2013/2014 and 20158 seasons was aimed to evaluateproductivity of Rhodes and Blue panic grasses as well as Alfalfa under sprinkler irrigation with foliar application of chemical substances that enable plants to cope with water stress. Each two forage grasses beside alfalfa were conducted in separate experiments. The results showed a significant effect due to cutting oncrude protein yield/fed. Irrigation every 7 days exceeded significantly total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield t/fed. A significant effect due to irrigation intervals on crude protein and fiber, extracting ether, ash and nitrogen free extract percentage, crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons.Rhodes grass produced highest values of total chlorophyll leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed**.** A significant effect due to forage species on crude protein and fiber, extract ether, ash and nitrogen free extract percentages, crude protein and fiber, extracting ether, ash and nitrogen free extract yields/fed during 2013/2014 and 2015 seasons**.** Sown Rhodes grass produced highest values of water use efficiency.Foliar application of proline at different concentrations significantly affected total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. The results clearly indicated foliar application of proline at 150 ppm produced the highest averages of total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. It could be concluded that a significant effect on percentages of crude fiber, ether extract, ash and nitrogen free extract as well as crude fiber, ether extract, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. Foliar application of proline concentrationsat 150 ppm significantly affected wateruse efficiency. It could be summarized that irrigationRhodes grass every 7 days and prolinefoliar application at 150 ppm significantlymaximized forage yield and its quality.

Keywords: Alfalfa**,** Rhodes and Blue panic grasses, proline,forage green and dry matter yield per unite area, percentages of crude protein and fiber, ether extract, ash and nitrogen free extract**,** water use efficiency.

1. Introduction

Egypt, identical other evolving countries positioned in the arid and semi-arid regions, faces four major problems namely of high degree of population increase and in the same time have limited natural resources of good quality water and existence of salt affected soil as well as shortage of forage feed**.** In Egypt, soil and water resources is limited, so we cultivate forage crops in new reclaimed soil with methods need low in water like foliar irrigation. Water use efficiency depends on the amount of water available in the soil, plus the amount of water that enters the soil. Species with greater plant root depth can access more water, and others are more efficient at converting available water into plant dry matter. Rhodes Grass (*Chloris gayana*Kunth) pastures endure for more three years, due to a combination of stresses. It resumes active growth in early spring, and grows opportunistically throughout summer depending on moisture availability. Rhodes grass very tolerant to low fertility, cutting or grazing and weed control. The stand should be maintained in a leafy condition by fairly regular cutting/slashing or grazing, as the feeding value declines rapidly with onset of flowering *i.e.* going into the mature stage **(FAO, 2013).**

Blue panic (*Panicumantidotale*, Retz.) is a native of Southeast Asia. It is a robust and shortly rhizomatous perennial grass that grows up to 1.5 m with very deep root system **(Jacobs and Wall, 1993). Al-Soqeer and Al-Ghumaiz (2012)** showed that a significant effect for cuts on dry forage yield. **Marais et al. (2006)** described that water use efficiency (WUE) is a way to evaluate plant species in terms of their ability to produce with a certain amount water available. There are many factors affectingWUE, including the type of plant/plant community, soil type, soil depth, climatic conditions, frequency and intensity of watering and utilization practices. **Al-Suhaibani (2006)**stated 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-ton ha^{-1}, respectively. Moreover, both 1st and 2nd cut yield was about 85% of the total obtained forage.

Al-Soqeer and Al-Ghumaiz (2012)revealed that a significant effect for irrigation intervals on all studied agronomic characters. Expanding irrigation interval decreased all agronomic characters. 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. **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).**Elnazier-Sanaa (2010)**indicated that protein content increased with decreased seed rate and increased irrigation interval. The fiber content increased with the increased seed rate and the longest irrigation interval.

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. **Al-Solaimani et al. (2009)**concluded that decreasing irrigation interval ceased increasing forage yield and yield components of dry forage yield /ha. As irrigation interval increased from 4 to 6 to 8 days dry forage yield decreased from 11.4 to 10.3 to 9.27 t/ha, respectively. The interaction between irrigation intervals and sulphur rates had significant effects on dry forage yield.**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.

Salinity tolerance at the cellular level involves the accumulation of endogenous compatible solutes, such as proline and glycine betaine**(Marcum and Murdoch 1994).**Proline accumulation was proposed to be associated with tolerance to osmotic and saline stress **(Mansour, 2000).**Proline improves salt tolerance in salt-sensitive rice by increasing proline accumulation and enhancing antioxidant defense system **(Hossain, 2006). Nazarbeygi et al. (2011)** found that salinity stress induced significant increase of proline content in leaves and roots of canola.
Talat*et al.* (2013) recounted that application of proline significantly ameliorates the harmful effects of salt stress. However, high concentration of proline (100 mM) application was more effective than 50 mM. Salt-affected soil is one of the most serious abiotic stress factors that reduce plant growth and development, therefore leading to a decline in crop productivity, especially in glycophyte species **(Qadir et al. 2008).Siddique et al. (2015)** reported that foliar application of proline resulted in a significant increase in plant growth parameters of rice. When the salt treated plants were supplied with exogenous proline, they produced significant amount of grain and straw yields. Sodium content and uptake by plants were decreased with foliar application of proline. It can be concluded that salt stress in rice reduce to a significant extent due to the exogenous application of proline.

2. Materials and Methods

This experiment designed to evaluating productivity of Rhodes and Blue panic grasses and Alfalfa under sprinkler irrigation with foliar application of chemical substances that enable plants to cope with water stress. Each two forage grasses beside alfalfa were conducted in separate experiments. Each experiment included two treatments of irrigation.
1-Irrigation quantities: Irrigation every 7i.e. 420 m^3 /feddan 100 m water depth or 14 days 210 m^3/feddan 50 m water depth.
2-Adaptive chemical materials to water stress: Four levels of proline i.e. 0, 50, 100 and 150 ppm were applied as foliar spray after three weeks of each cut, which play an adaptive role in plant stress tolerance.

The experiment laid out in split plot design with four replications. The two treatments of water irrigation every 7 days i.e. 420 m^3 /feddan or 14 days 210 m^3/feddan occupied the main plots. The sub plot treatment allocated with four rates of foliar spraying of proline i.e. 0, 50,100 and 150 mg/L. A combined analysis between the two water irrigation quantities was done. Combined analysis was done to determine the mean effects of the three studied forage crops. In 2013/2014 season green fodder three cuts were studied. Data was subjected to statistical analysis and means compare using LSD test at 5% level according to **Gomez and Gomez (1991).**

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

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

2-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.

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

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

5-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.

6- 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).

7-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) X root depth X Soil bulk density (1.76) X 10000

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

8-Crude protein (CP): The wet ash will have prepared and nitrogen be determined calorimetrically in the acid digest using the method recommended by **Kochand McMeekin (1924).** Then crude protein percent was calculated by multiplying total nitrogen percent X 6.25 as described by **Bolton and McCarthy(1962)**. Moreover, crude protein in Kg/faddan was calculated by multiplying crude protein percent X dry matter yield in Kg/faddan.

9- Ether extract (EE): Soxhelt apparatus will be used for determination of ether extract percent, heating by electric heater; cold water at 80^o 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 **AOAC (2000).** Moreover, ether extract in Kg/faddan was calculated by multiplying ether extract percent X yield of dry matter in Kg/faddan.

10- Crude fiber (CF): The usual Weende 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^o C before ashing in the usually way. Moreover, crude fiber in Kg/faddan was calculated by multiplying crude fiber percent X yield of dry matter in Kg/faddan.

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

12-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 X yield of dry matter in Kg/faddan.

3. Results and Discussions

3.1. Cuttings 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 and dry matter yield/fed as affected by cuttings, irrigation treatments, forage plant species and foliar application of proline concentrations. The results clearly showed that cuttings insignificantly affected total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. Concerning to chemical dry forage composition, the results presented in Tables (2 and 3) clearly showed insignificant effect due to cutting on crude protein and fiber, extracting ether, ash and nitrogen free extract percentage, crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. However, crude protein yield/fed significantly affecting by cuts, highest protein yield was obtained from fourth and fifth cuts, which were 187.2 and 187.4 kg/fed, respectively.

However, **Al-Soqeer and Al-Ghumaiz (2012)** showed that a significant effect for cuts on dry forage yield. Concerning to water use efficiency, the results presented in Table 2 clearly showed a significant effect due to different cutting. First cut produced highest values of water use efficiency (4.85), whilst the lowest values were obtained from the third cut (3.87) during 2013/2014 and 2015 seasons. **Marais et al. (2006)** reported that water use efficiency is a way to evaluate plant species in terms of their ability to produce with a certain amount water available. There are many factors affectingwater use efficiency, including the type of plant/plant community, soil type, soil depth, climatic conditions, frequency and intensity of watering and utilization practices.

3.2. 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 and dry matter yield/fed. The results indicated that irrigation every 7 days exceeded significantly total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield t/fed than irrigation every 14 days, which were 18.15, 23.93, 68.11, 320.7, 3.182 and 2.052, respectively. However, the lowest values of total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield t/fed was obtained from irrigation every 14 days, which were 12.49, 12.25, 32.24, 148.1, 1.003 and 0.655, 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-ton ha^{-1}, respectively. Moreover, both 1st and 2nd cut yield was about 85% of the total obtained forage.**Al-Soqeer and Al-Ghumaiz (2012)** showed that a significant effect for irrigation intervals on all studied agronomic characters. Expanding irrigation interval decreased all agronomic characters. 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. **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 *i.e.* irrigation every 6 days.

Concerning to chemical dry forage composition, the results presented in Tables (2 and 3) clearly showed a significant effect due to irrigation intervals on crude protein and fiber, extracting ether, ash and nitrogen free extract percentage, crude fiber, extracting ether, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. Highest percentages of crude protein and fiber, extracting ether, ash and nitrogen free extract were produced from irrigation every 14 days, the corresponding data were 14.31, 25.45, 1.96, 11.51 and 46.78%, respectively. However, the lowest percentages were produced from irrigation every 14 days. Highest crude protein and fiber, extracting ether, ash and nitrogen free extract yields/fed were produced from irrigation every 7 days, the corresponding data were 270.3, 541.8, 193.8, 222.8 and 976.7 kg/fed, respectively. However, the lowest yields/fed were produced from irrigation every 14 days.

Elnazier-Sanaa (2010) stated that protein content increased with decreased seed rate and increased irrigation interval. The fiber content increased with the increased seed rate and the longest irrigation interval.**Bakhashwain (2010)** concluded that the lowest dry matter percentage was observed for alfalfa sown. The crude protein(%), crude fiber (%) and ash contents (%) were significantly affected by the different sowing ratios. Alfalfa fodder (100%) contained the highest crude protein content (17.17%), and ash % (10.0%), while the highest crude fiber (%) was produced from the mixture of 75% and 100% Rhodes grass with values of 17.99% and 17.3% respectively.

Table 1: Averages 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, proline concentrations and their interactions, as average of three cuts, during 2013/2014 and 2015 seasons.

Characters Treatments	Total chlorophyll	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	15.35	18.31	49.83	233.6	2.034	1.306
2nd cut	15.36	17.81	49.59	234.8	2.096	1.337
3rd cut	14.93	17.30	49.07	232.8	2.060	1.315
4th cut	15.36	18.54	51.06	236.5	2.150	1.402
5th cut	15.60	18.51	51.34	234.1	2.143	1.406
LSD at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	NS
I-Irrigation intervals:						
Every 7 days	18.15	23.93	68.11	320.7	3.182	2.052
Every 14 days	12.49	12.25	32.24	148.1	1.003	0.655
F-Test at 5 %	*	*	*	*	*	*
F- test C×I	*	*	*	*	*	*
F-Forage species:						
Alfalfa	17.29	14.10	38.38	130.9	1.108	0.726
Rhodes grass	15.39	21..83	63.04	336.7	3.037	1.979
Blue panic grass	13.29	18.34	49.11	235.5	2.132	1.359
LSD at 5 %	0.13	0.16	0.28	0.42	0.070	0.014
F- test C×F	N.S.	N.S.	*	*	N.S.	N.S.
F- test I×F	*	*	*	*	*	*
F- test C×I ×F	*	*	*	*	N.S.	N.S.
P- Proline levels:						
0 ppm	14.77	17.50	49.27	231.2	2.067	1.329
50 ppm	15.00	17.94	49.71	233.4	2.086	1.347
100 ppm	15.56	18.32	50.54	235.6	2.100	1.368
150 ppm	15.97	18.68	51.20	237.3	2.116	1.371
LSD at 5 %	0.09	0.12	0.23	0.36	0.048	0.016
C×P	*	*	N.S.	*	N.S.	N.S.
I×P	N.S.	*	N.S.	*	*	*
F×P	*	N.S.	N.S.	*	N.S.	N.S.
C×I ×P	*	N.S.	N.S.	*	N.S.	N.S.
C ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C×I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2: Averages of water use efficiency, percentages of crude protein and fiber, ether extract ash and nitrogen free extract as affected by cuttings, irrigation intervals, forage species and their interactions for the five cuts during 2013/2014 and 2015 seasons.

Characters Treatments	Water Use Efficiency WUE%	Crude Protein %	Crude Fiber %	Ether Extract %	Ash content %	Nitrogen free extract %
C-Cutting effects:						
1st cut	4.85	14.13	24.95	1.92	11.45	47.65
2nd cut	3.88	14.20	25.11	1.92	11.40	47.37
3rd cut	3.87	14.29	25.28	1.91	11.38	47.15
4th cut	4.15	14.35	25.33	1.93	11.33	47.01
5th cut	4.17	14.39	25.25	1.92	11.44	46.70
LSD at 5 %	0.21	N.S.	N.S.	N.S.	N.S.	N.S.
I-Irrigation intervals:						
Every 7 days	4.87	14.21	24.92	1.89	11.27	47.57
Every 14 days	3.11	14.31	25.45	1.96	11.51	46.78
F-test	*	*	*	*	*	*
F- test C×I	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F-Forage species:						
Alfalfa	2.13	18.81	16.46	2.26	13.01	49.51
Rhodes grass	5.90	11.82	26.17	1.81	10.27	49.73
Blue panic grass	3.93	12.17	32.93	1.70	10.90	42.29
LSD at 5 %	0.29	0.17	0.17	0.03	0.09	0.51
F- test C×F	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F- test I×F	*	N.S.	N.S.	N.S.	N.S.	N.S.
F- test C×I ×F	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
P- Proline levels:						
0 ppm	3.92	13.90	24.26	1.79	10.84	49.18
50 ppm	3.97	14.09	25.03	1.90	11.17	47.79
100 ppm	4.01	14.32	25.49	1.98	11.60	46.69
150 ppm	4.05	14.76	25.97	2.02	11.97	45.06
LSD at 5 %	0.03	0.13	0.05	0.05	0.09	0.14
C×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
I×P	*	N.S.	N.S.	N.S.	*	N.S.
C×I ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F×P	*	N.S.	N.S.	*	*	N.S.
C ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C×I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 3: Averages of crude protein and fiber, ether extract ash and nitrogen free extract yield in Kg/fed as affected by cuttings, irrigation intervals, forage species and their interactions for the five cuts during 2013/2014 and 2015 seasons.

Characters Treatments	Crude Protein Yield Kg/fed	Crude Fiber Yield Kg/fed	Ether Extract Yield Kg/fed	Ash yield Kg/fed	Nitrogen free extract Yield Kg/fed
C-Cutting effects:					
1st cut	169.7	346.1	99.1	142.5	626.5
2nd cut	173.6	348.7	101.5	144.1	632.3
3rd cut	173.6	350.2	101.5	143.9	624.6
4th cut	187.2	374.0	105.8	152.8	663.5
5th cut	187.4	374.7	107.3	154.0	664.0
LSD at 5 %	2.8	7.2	N.S.	2.9	7.3
I-Irrigation intervals:					
Every 7 days	270.3	541.8	193.8	222.8	976.7
Every 14 days	86.3	175.2	12.3	72.5	307.6
F-test	*	*	*	*	*
F- test C×I	N.S.	N.S.	N.S.	N.S.	N.S.
F-Forage species:					
Alfalfa	136.5	118.6	16.2	94.2	361.4
Rhodes grass	233.3	516.3	270.2	201.9	991.4
Blue panic grass	165.2	441.4	22.7	146.3	573.7
LSD at 5 %	4.0	9.9	8.2	4.1	10.1
F- test C×F	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.
P- Proline levels:					
0 ppm	170.8	341.8	92.4	137.7	658.1
50 ppm	175.0	354.8	101.8	144.0	648.1
100 ppm	180.6	364.4	108.2	151.2	637.6
150 ppm	186.8	373.9	109.9	157.1	625.2
LSD at 5 %	2.0	1.1	4.3	1.5	5.9
C×P	N.S.	N.S.	N.S.	N.S.	N.S.
I×P	*	*	*	*	*
C×I ×P	N.S.	N.S.	N.S.	N.S.	N.S.
F×P	*	*	*	*	*
C ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.
I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.
C×I ×F ×P	N.S.	N.S.	N.S.	N.S.	N.S.

In agricultural practice, the sufficient and balanced application of irrigation water and nutrients are important methodology to obtain maximum yield per unit area. The results presented in Table (2) clearly showed a significant effect due to irrigation intervals. irrigation at 7 days intervals produced highest values of water use efficiency (4.87), whilst the lowest values were obtained from irrigation at 14 days intervals (3.11) during 2013/2014 and 2015 seasons. **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.

3.3 Interaction effect between cuttings and irrigation intervals:

The results in Table (4) clearly indicated that the interaction effect among cuttings and irrigation intervals on total chlorophyll, the results showed that this interaction significantly affected total chlorophyll. The results clear indicated that highest total chlorophyll was obtained from the fifth cut and irrigation every 7 days, which was 18.51. However, the lowest total chlorophyll was produced from the third cut and irrigation every 14 days, which was 12.26.

Fig.4: Means of total chlorophyll (SPAD) as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	**Irrigation intervals**	
	Every 7 days	**Every 14 days**
1st cut	18.27	12.46
2nd cut	18.13	12.57
3rd cut	17.60	12.26
4th cut	18.27	12.46
5th cut	18.51	12.71
LSD at 5 %	0.14	

Concerning to the interaction effect between cuttings and irrigation intervals on leaf area/plant (cm^2), the results in Table (5) showed that this interaction significantly affected leaf area/plant (cm^2). Highest values of leaf area/plant (cm^2) was produced from the first or the second cut and irrigation every 7 days without significant differences, which were 24.17 and 24.09 cm^2/plant, respectively. However, the lowest values of leaf area/cm^2 was produced from the third cut and irrigation every 14 days, which was 10.99 cm^2/plant.

With respect to the interaction between cuttings and irrigation intervals on plant height (cm), the results in Table (6) clearly revealed that this interaction significantly affected plant height. The results indicated that tallest plants were produced from the second cut when plants were irrigated every 7 days without significant differences, which were 68.65 and 68.61 cm, respectively. However, the shortest plants were produced from the second or third cut when irrigated every 14 days without significant differences, which was 30.53 and 30.18 cm, respectively.

Fig.5: Averages of leaf area (cm^2) as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 7 days	Every 14 days
1^{st} cut	23.90	12.73
2^{nd} cut	23.91	11.71
3^{rd} cut	23.62	10.99
4^{th} cut	24.17	12.93
5^{th} cut	24.09	12.93
LSD at 5 %	0.33	

Fig.6: Means of plant height (cm) as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 10 days	Every 14 days
1^{st} cut	67.03	32.63
2^{nd} cut	68.65	30.53
3^{rd} cut	67.97	30.18
4^{th} cut	68.31	33.82
5^{th} cut	68.61	34.08
LSD at 5 %	0.46	

Regarding the interaction effect between cuttings and irrigation intervals on stem number/m^2, the results in Table (7) clear indicated that this interaction significantly affected number of stems/m^2. The results fourth cut and irrigation every 7 days, which was 324.5 stems/m^2. However, the lowest number of stems/m^2 was obtained from the third cut and irrigation every 14 days, which was 145.6 stems/m^2.

With respect to the interaction effect between cuttings and irrigation intervals on forage green yield/fed, the results presented in Table (8) showed that this interaction significantly affected forage green yield/fed. The results indicated that the third cut and irrigation every 7 days produced highest forage green yield/fed, which was 3.266 t/fed. However, the lowest forage green yield/fed was obtained from the first, second and third cuts and irrigation every 14 days without significant differences, which were 0.972, 0.979 and 0.974 t/fed, respectively.

Fig.7: Averages of number of stems/m^2 as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 7 days	Every 14 days
1st cut	315.0	152.1
2nd cut	322.1	147.7
3rd cut	320.2	145.6
4th cut	324.5	148.6
5th cut	321.4	146.7
LSD at 5 %	0.71	

Fig.8: Means of forage green yield (ton/fed) as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 7 days	Every 14 days
1st cut	3.097	0.972
2nd cut	3.162	0.979
3rd cut	3.147	0.974
4th cut	3.266	1.046
5th cut	3.243	1.044
LSD at 5 %	0.091	

Regarding to the interaction effect between cuttings and irrigation intervals on forage dry matter yield/fed, the results presented in Table (9) indicated that this interaction significantly affected forage dry matter yield/fed. The results indicated that the fourth or fifth cut and irrigation every 7 days produced highest forage dry matter yield/fed without significant differences, which was 2.111 and 2.115 t/fed, respectively. However, the lowest forage dry matter yield/fed was obtained from the first, second and third cuts and irrigation every 14 days without significant differences, which were 0.630, 0.627 and 0.625 t/fed, respectively.

Fig.9 Averages of forage dry matter yield kg/fed as affected by the interaction among cuttings and irrigation intervals during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals	
	Every 7 days	Every 14 days
1st cut	1.982	0.630
2nd cut	2.048	0.627
3rd cut	2.007	0.625
4th cut	2.111	0.695
5th cut	2.115	0.698
LSD at 5 %	0.028	

Concerning to chemical dry forage composition, the results presented in Tables (2and 3) clearly showed insignificant effect due to the interaction effect between irrigation intervals and cutting on crude protein and fiber, extracting ether, ash and nitrogen free extract percentage, crude protein yield/fed, that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

3.4. Forage species effect:

The results in Table 1 showed that forage species significantly differed in means of total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. The results revealed that Rhodes grass produced highest values of total chlorophyll leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed, which were 15.39, 21.83, 63.04, 336.7, 3.037 and 1.979, respectively. However, the lowest of total chlorophyll from sown blue panic grass (13.29) and leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. were obtained from sowing alfalfa, which were 14.10, 38.38, 130.9, 1.108 and 0.726, respectively.

Shahbaz et al. (2011) reported that six ecotypes of *Panicumantidotale* were grown under normal growth conditions for six months, after which time they were subjected to three drought levels (control (normal irrigation), 60% and 30% field capacity). Six ecotypes of *Panicumantidotale* were produced higher quantity of plant biomass and net CO2 assimilation rate as compared to the others. Water use efficiency and shoot N the populations collected from habitats containing with high amount of sludge and that from dry shady conditions performed better performance as compared to the other populations.

Al-Soqeer and Al-Ghumaiz (2012) showed that Rhodes grass had superior performance for all agronomic character comparing with other genotypes. **Abusuwar and Eldin (2013)** pointed out that the two grasses (Teff and Rhodes grass) were more drought tolerant than the two legumes (alfalfa and Siratro) as they resulted in higher plant density, higher number of leaves and higher productivity under all treatments. **Osman *et al.* (2014)** concluded that Rhodes grass significantly out yielded forage in all cuts other than the first one.

Concerning to chemical dry forage composition, the results offered in Tables (2 and 3) clearly revealed a significant effect due to forage species on crude protein and fiber, extract ether, ash and nitrogen free extract percentages, crude protein and fiber, extracting ether, ash and nitrogen free extract yields/fed during 2013/2014 and 2015 seasons. Highest percentages of crude protein, extract ether and ash were produced from sown alfalfa, the corresponding data were 18.81, 2.26 and 13.01% respectively. Highest percentages of crude fiber and nitrogen free extract were produced from sown Rhodes grass, the corresponding data were 26.17 and 49.73%, respectively. Moreover, Highest yield/fed of crude protein and fiber, extract ether, ash and nitrogen free extract were produced from sown Rhodes grass. The corresponding data were 233.3, 516.3, 270.2, 201.9 and 991.4, respectively.

Bakhashwain (2010) concluded that the lowest dry matter percentage was also observed for alfalfa sown alone, with high significant differences with all other sowing ratios. The crude protein (CP) (%), crude fiber (CF) (%) and ash contents (%) were significantly affected by the different sowing ratios. Alfalfa fodder (100%) contained the highest crude protein content (17.17%), and ash % (10.0%), while the highest crude fiber (%) was produced from the mixture of 75% and 100% Rhodes grass with values of 17.99% and 17.3% respectively.

The results presented in Table 2 clearly showed a significant effect due to forage species on water use efficiency. Sown Rhodes grass produced highest values of water use efficiency (5.90), whilst the lowest values were obtained from sown alfalfa (2.13) during 2013/2014 and 2015 seasons. **Hanson et al. (2008)**reported that deficit irrigation reduced ET (Evapotranspiration) but the ET difference between fully-irrigated and deficit-irrigated alfalfa was site specific. Yields were reduced by deficit irrigation.

3.5. Interaction effect between cuttings and forage species:

Regarding the interaction effect between cuttings and forage species on total chlorophyll and leaf area/plant (cm^2), the results in Table 1presented insignificant effect due to this interaction on total chlorophyll and leaf area/plant (cm^2).

Concerning to the interaction effect between cuttings and forage species on plant height, the results in Table (10) point out that this interaction significantly affected plant height. The results showed that tallest plants were obtained from the fifth cut and sowing Rhodes grass (64.29 cm). On contrary, the shortest plants were produced from the second and third cut and sowing alfalfa without significant differences, which were 47.45 and 36.5 cm, respectively.

Fig.10: Means of plant height (cm) as affected by the interaction among cuttings and forage species during 2013/2014 and 2015 seasons.

Cuttings	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
1st cut	38.28	63.12	48.09
2nd cut	37.45	62.19	49.13
3rd cut	36.05	61.66	48.72
4th cut	39.55	63.97	49.67
5th cut	39.79	64.29	49.95
LSD at 5 %	0.64		

Regarding to the interaction effect between cuttings and forage species on number of stems/m^2, the results in Table (11) clearly showed that this interaction significantly affected number of stems/m^2. The results indicated that highest number of stems/m^2 was produced from the fourth cut and sowing Rhodes grass (339.6 stems/m^2). However, the lowest number of stems/m^2 was obtained from the third cut and sowing alfalfa (129.0 stems/m^2).

Fig.11: Averages of number of stems/m^2 as affected by the interaction among cuttings and forage species during 2013/2014 and 2015 seasons.

Cuttings	Forage species		
	Alfalfa	Rhodes grass	Blue panic grass
1st cut	132.6	334.3	234.2
2nd cut	130.5	338.3	235.8
3rd cut	129.0	335.4	234.3
4th cut	132.6	339.6	237.5
5th cut	132.2	336.2	235.8
LSD at 5 %	0.95		

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

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

3.6. Interaction effect between irrigation intervals and forage species:

Concerning to the interaction effect between irrigation intervals and forage species on total chlorophyll, the results in Table (12) clearly indicated that this interaction significantly affected average of total chlorophyll. Irrigation every 7 days and sown alfalfa produced highest total chlorophyll (20.21) and irrigation every 14 days and sown Blue panic grass produced the lowest total chlorophyll (11.17).

Fig.12: Averages of total chlorophyll (SPAD) as affected by the interaction among 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 7 days	20.21	18.85	15.42
Every 14 days	14.37	11.94	11.17
LSD at 5 %	0.19		

With respect to the interaction effect between irrigation intervals and forage species on leaf area/plant (cm^2), the results in Table (13) clearly indicated that this interaction significantly affected leaf area/plant (cm^2). The results clearly indicated that highest values leaf area/plant (cm^2) was produced from irrigation every 7 days and sowing Rhodes grass (29.02 cm^2/plant). However, that lowest values leaf area/plant (cm^2) was obtained from irrigation every 14 days and sowing alfalfa, which was 10.07 cm^2/plant.

Fig.13: Averages of leaf area ($cm^{2/}$plant) as affected by the interaction among 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 7 days	18.14	29.02	24.65
Every 14 days	10.07	14.66	12.04
LSD at 5 %	0.23		

Regarding to the interaction effect between irrigation intervals and forage plant species on plant height, the results in Table (14) clearly revealed that this interaction significantly affected plant height. The results showed that tallest plants were produced from irrigation every 7 days and sowing Rhodes grass (81.63 cm). On contrary, the shortest plants were obtained from irrigation every 14 days and sowing alfalfa (24.81 cm).

Fig.14: Means of plant height (cm) as affected by the interaction among 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 7 days	51.96	81.63	70.75
Every 14 days	24.81	44.46	27.48
LSD at 5 %	0.41		

Concerning to the effect of the interaction between irrigation intervals and forage species on average number of stems/m^2, the results in Table (15) clearly revealed that this interaction significantly affected number of stems/m^2. The results showed that highest number of stems/m^2 was produced from irrigation every 7 days and sowing Rhodes grass (449.3 stems/m^2). However, the lowest number of stems/m^2 was produced from irrigation every 14 days and sowing alfalfa (98.6 stems/m^2).

Fig.15:Averages number of stems/m^2 as affected by the interaction among 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 7 days	163.3	449.3	349.6
Every 14 days	98.6	224.3	121.5
LSD at 5 %	0.6		

Regarding to the interaction effect between irrigation intervals and forage species on forage green yield/fed, the results in Table (16) indicated that this interaction significantly affected forage green yield/fed. The results showed that highest forage green yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (4.428 t/fed). However, the lowest forage green yield/fed (4.477 kg/fed) was produced from irrigation every 14 days and sown alfalfa (0.505 t/fed).

Fig.16: Averages of forage green yield (ton/fed) as affected by the interaction among 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 7 days	1.712	4.477	3.359
Every 14 days	0.505	1.598	0.906
LSD at 5 %	0.056		

Regarding to the interaction effect between irrigation intervals and forage species on forage dry matter yield/fed, the results in Table (17) clearly revealed that this interaction significantly affected forage green yield/fed. The results showed that highest forage dry matter yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (2.940 t/fed). However, the lowest forage dry matter yield/fed was produced from irrigation every 14 days and sown alfalfa (0.342t/fed).

Fig.17: Averages of forage dry matter yield (ton/fed) as affected by the interaction among 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 7 days	1.111	2.940	2.106
Every 14 days	0.342	1.012	0.612
LSD at 5 %	0.019		

Regarding to the interaction effect between irrigation intervals and studied forage species water use efficiency, the results in Table (18) clearly indicated that this interaction significantly affected water use efficiency during 2013/2014 and 2015 seasons. The results exposed that highest values of water use efficiency were produced from irrigation every 7 days and sowing Rhodes grass (7.00). However, the lowest values of water use efficiency were produced from irrigation every 14 days and sown alfalfa (1.64).

Fig. 18: Averages of water use efficiency as affected by the interaction among 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 7 days	2.64	7.00	4.96
Every 14 days	1.62	4.81	2.90
LSD at 5 %	0.41		

Regarding to the interaction effect between irrigation intervals and studied forage species on percentages of crude protein and fiber, ether extract ash and nitrogen free extract, the results in Table 2 clearly indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

With respect to the interaction effect between irrigation intervals and studied forage species on crude protein yield/fed, the results in Table (19) clearly indicated that this interaction significantly affected crude protein yield/fed during 2013/2014 and 2015 seasons. The results exposed that highest crude protein yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (346.3 Kg/fed). However, the lowest crude protein yield/fed was produced from irrigation every 14 days and sown alfalfa (64.4 Kg/fed).

With respect to the interaction effect between irrigation intervals and studied forage species on crude fiber yield/fed, the results in Table (20) clearly indicated that this interaction significantly affected crude fiber yield/fed during 2013/2014 and 2015 seasons. The results exposed that highest crude fiber yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (765.6 Kg/fed). However, the lowest crude fiber yield/fed was produced from irrigation every 14 days and sown alfalfa (57.0 Kg/fed).

Fig. 19: Averages of crude protein yield/fed as affected by the interaction among 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 7 days	208.6	346.3	256.0
Every 14 days	64.4	120.2	74.3
LSD at 5 %	4.15		

Fig. 20: Averages of crude fiber yield/fed as affected by the interaction among 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 7 days	180.2	765.6	679.7
Every 14 days	57.0	267.1	203.0
LSD at 5 %	10.2		

Regarding to the interaction effect between irrigation intervals and studied forage species on ether extract yield/fed, the results in Table (21) clearly indicated that this interaction significantly affected ether extract yield/fed during 2013/2014 and 2015 seasons. The results exposed that highest ether extract yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (521.8 Kg/fed). However, the lowest ether extract yield/fed was produced from irrigation every 14 days and sown alfalfa (7.7 Kg/fed).

Fig. 21: Averages of ether extractyield/fed as affected by the interaction among 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 7 days	24.8	521.8	34.8
Every 14 days	7.7	18.6	10.7
LSD at 5 %	8.4		

Concerning to the interaction effect between irrigation intervals and studied forage species on ash yield/fed, the results in Table (22) clearly indicated that this interaction significantly affected ash yield/fed during 2013/2014 and 2015 seasons. The results exposed that highest ash yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (298.6 Kg/fed). However, the lowest ash yield/fed was produced from irrigation every 14 days and sown alfalfa (44.8 Kg/fed).

Fig. 22: Averages of ether extractyield/fed as affected by the interaction among 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 7 days	143.6	298.6	225.2
Every 14 days	44.8	105.3	67.3
LSD at 5 %	4.2		

Concerning to the interaction effect between irrigation intervals and studied forage species on nitrogen free extract yield/fed, the results in Table (23) clearly indicated that this interaction significantly affected free extract yield/fed during 2013/2014 and 2015 seasons. The results exposed that highest free extract yield/fed was produced from irrigation every 7 days and sowing Rhodes grass (1482.8 Kg/fed). However, the lowest free extract yield/fed was produced from irrigation every 14 days and sown alfalfa (167.8 Kg/fed).

Fig. 23: Averages of ether extractyield/fed as affected by the interaction among 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 7 days	555.1	1482.8	892.3
Every 14 days	167.8	500.0	255.2
LSD at 5 %	10.4		

3.7 Interaction effect between cuttings, irrigation intervals and forage species effect:

Concerning to the interaction effect between cuttings, irrigation intervals and plant species on total chlorophyll, the results in Table (24) clearly indicated that this interaction significantly affected total chlorophyll. The results clearly showed that highest total chlorophyll values were produced from cuttings at first, second, fourth and fifth cuts of alfalfa plants when irrigated every 7 days without significant differences, which were 20.22, 20.35, 20.22 and 20.48, respectively. On contrary, the lowest values of total chlorophyll were produced from the first, second, third, fourth and fifth cuts of Blue panic grass when irrigated every 14 days without significant differences, which were 11.16, 11.27, 1.90, 11.16 and 11.38, respectively.

Regarding to the interaction affect between cuttings, irrigation intervals and forage species on leaf area/plant (cm^2), the results presented in Table (25) clearly showed that this interaction significantly affected average leaf area/plant. The results indicated that highest values leaf area/plant (cm^2) was produced from the first, second, fourth or fifth cut and irrigation every 7 days with sowing Rhodes grass without significant differences, which were 28.96, 28.99, 29.44 and 29.13, respectively. However, the lowest values of leaf area/plant (cm^2) was produced from the first or the second cut with irrigation every 14 days with sowing alfalfa plants without significant differences (9.02).

Fig.24: Averages of total chlorophyll (SPAD) as affected by the interaction between cuttings, irrigation intervals and forage species during 2013/2014 season.

Cuttings	Irrigation intervals					
	Every 7 days			Every 14 days		
	Forage species			Forage species		
	Alfalfa	Rhodes grass	Blue panic grass	Alfalfa	Rhodes grass	Blue panic grass
1st cut	20.22	18.88	15.73	14.21	12.01	11.16
2nd cut	20.35	18.94	15.11	14.58	11.86	11.27
3rd cut	19.77	18.45	14.59	14.40	11.50	10.90
4th cut	20.22	18.88	15.73	14.21	12.01	11.16
5th cut	20.48	19.10	15.94	14.46	12.29	11.38
LSD at 5 %	0.41					

Fig.25: Means of leaf area (cm^2) as affected by the interaction among cuttings, irrigation intervals and forage species during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals					
	Every 7 days			Every 14 days		
	Forage species			Forage species		
	Alfalfa	Rhodes grass	Blue panic grass	Alfalfa	Rhodes grass	Blue panic grass
1st cut	18.12	28.96	24.61	10.63	15.18	12.38
2nd cut	18.04	28.99	24.72	9.02	14.54	11.58
3rd cut	17.79	28.76	24.31	9.02	12.91	11.02
4th cut	18.45	29.24	24.81	10.09	15.27	12.64
5th cut	18.33	29.13	24.81	10.81	15.41	12.58
LSD at 5 %	0.51					

Concerning to the interaction effect between cuttings, irrigation intervals and forage species on plant height, the results of this interaction significantly affected plant height as shown in Table (26). The results revealed that tallest plants were obtained from the second, fourth or fifth cut and irrigation every 7 days and sowing Rhodes grass without significant differences, which were 81.83, 81.83 and 82.18 cm, respectively. However, the shortest plants were obtained from the third cuts and irrigation every 14 days of alfalfa without significant differences, which were 22.16 and 21.83 cm, respectively.

With respect to the interaction effect between cuttings, irrigation intervals and forage species on average number of stems/m^2, the results in Tale (27) indicated that this interaction significantly affected average number of stems/m^2. The results revealed that highest average number of stems/m^2 was obtained from the fourth cut and irrigation every 7 with sown

Rhodes grass (452.9 stems/m^2). On contrary, the third cut and irrigation every 14 days of alfalfa plants (96.2 stems/m^2).

Fig. 26: Means of plant height as affected by the interaction between cuttings, irrigation intervals and forage species during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals					
	Every 7 days			Every 14 days		
	Forage species			Forage species		
	Alfalfa	Rhodes grass	Bluepanic grass	Alfalfa	Rhodes grass	Blue panic grass
1st cut	50.80	81.06	69.22	25.76	45.17	26.96
2nd cut	52.74	81.83	71.38	22.16	42.54	26.89
3rd cut	51.87	81.24	70.81	21.83	42.08	26.64
4th cut	52.09	81.83	71.01	27.01	46.11	28.34
5th cut	52.29	82.18	71.36	27.29	46.40	28.54
LSD at 5 %	0.91					

The results in Table 1 clearly showed that the interaction between cuttings, irrigation intervals and forage species on forage green and dry matter yield/fed. insignificantly affected forage green and dry matter yield/fed.

Fig.27: Averages number of stems/m^2 as affected by the interaction between cuttings, irrigation intervals and forage species during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals					
	Every 7 days			Every 14 days		
	Forage species			Forage species		
	Alfalfa	Rhodes grass	Blue panic grass	Alfalfa	Rhodes grass	Blue panic grass
1st cut	162.4	442.4	341.1	102.8	226.2	127.3
2nd cut	163.4	451.3	351.4	97.5	225.3	120.3
3rd cut	161.8	449.4	349.6	96.2	221.4	119.1
4th cut	166.5	452.9	345.1	98.6	226.3	120.8
5th cut	162.3	450.2	351.8	98.1	222.1	119.9
LSD at 5 %	1.3					

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

3.8. Proline concentration effect:

With respect to effect of foliar application of proline concentrations on total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed., the results in Table 1 showed that foliar application of proline at different concentrations significantly affected total chlorophyll (SPAD), leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. The results clearly indicated foliar application of proline at 150 ppm produced the highest averages of total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed. Which were 15.97, 18.68, 51.20, 237.3, 2.116 and 1.1.371, respectively.However, the lowest averages of total chlorophyll, leaf area (cm^2), plant height (cm), number of stems/m^2, forage green and dry matter yield/fed was obtained from without foliar application of proline, which were 14.77, 17.50, 49.27, 231.2, 2.067 and 1.329, respectively.Proline accumulation was proposed to be associated with tolerance to osmotic and saline stress **(Mansour, 2000).** Proline improves salt tolerance in salt-sensitive rice by increasing proline accumulation and enhancing antioxidant defense system **(Hossain, 2006).** Among treatments aimed at increasing plant resistance to salt and drought stress, application of glycine betaine (GB) has been tested in recent years. GB is one of the compatible solutes that many plant species accumulate in the cytoplasm and chloroplasts during drought or salt stress and it appears to have several roles in enhancing abiotic stress resistance, by balancing vacuolar osmotic potential, by protecting cell structures and functions during stress, by inducing the expression of specific stress-responsive genes **(Chen and Murata 2008, 2011).**

Nazarbeygi et al. (2011) found that salinity stress induced significant increase of proline content in leaves and roots of canola. **Talat*et al.* (2013)** reported that application of proline significantly ameliorates the harmful effects of salt stress. However, high concentration of proline (100 mM) application was more effective than 50 mM.**Scalia et al. (2014)** conclude that in weeping alkali grass(Puccinelliadistans L.) was more sensitive to salinity than tall fescue and that foliar application of glycine betaine (GB) relieved salt stress symptoms in tall fescue, but had no significant effect on weeping alkali grass. The results showed that that at least up to an 8-week period, tall fescue resisted saline irrigation and resistance was improved by foliar application of GB, while high salinity conditions reduced growth in weeping alkali grass.Salt-affected soil is one of the most serious abiotic stress factors that reduce plant growth and development, therefore leading to a decline in crop productivity, especially in glycophyte species **(Qadir et al. 2008).Siddique et al. (2015)** reported that foliar application of proline resulted in a significant increase in plant growth parameters of rice. When the salt treated plants were supplied with exogenous proline, they produced significant amount of grain and straw yields. Sodium content and uptake by plants were decreased with foliar application of proline. It can be concluded that salt stress in rice reduce to a significant extent due to the exogenous application of proline.

Regarding to effect of foliar application of proline concentrations on percentages of crude fiber, ether extract, ash and nitrogen free extract as well as crude fiber, ether extract, ash and nitrogen free extract yield/fed, the results in Tables (2 and 3) clearly indicated that a significant effect on percentages of crude fiber, ether extract, ash and nitrogen free extract as well as crude fiber, ether extract, ash and nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. Highest of percentages of crude fiber, ether extract and ash were produced from foliar application of proline at 150 ppm, which were 14.76, 25.97, 2.02 and 11.97%, respectively. However, highest nitrogen free extract percentage was produced from without prolien application (49.18%). Moreover, highest crude fiber, ether extract and ash yield/fed were produced from foliar application of proline at 150 ppm, which were 186.8, 373.9, 109.9, 157.1 Kg/fed, respectively.

However, highest nitrogen free extract yield was produced from without prolein foliar application (658.1 Kg/fed). In addition, lowest percentages of crude fiber, ether extract and ash as well as crude fiber, ether extract and ash yield/fed were produced from without proline foliar application. However, lowest percentages and yield/fed of nitrogen free extract were obtained from foliar application of proline at 150 ppm. Proline accumulation was proposed to be associated with tolerance to osmotic and saline stress **(Mansour, 2000).**Proline improves salt tolerance in salt-sensitive rice by increasing proline accumulation and enhancing antioxidant defense system **(Hossain, 2006).** Among treatments aimed at increasing plant resistance to salt and drought stress, application of glycine betaine (GB) has been tested in recent years. GB is one of the compatible solutes that many plant species accumulate in the cytoplasm and chloroplasts during drought or salt stress and it appears to have several roles in enhancing abiotic stress resistance, by balancing vacuolar osmotic potential, by protecting cell structures and functions during stress, by inducing the expression of specific stress-responsive genes **(Chen and Murata 2008, 2011).**

With respect to effect of foliar application of proline concentrations on wateruse efficiency, results in Table (2**)** clearly indicated that foliar application of proline concentrations significantly affected wateruse efficiency. Highest values of wateruse efficiency were produced from foliar application of proline at concentration 150 ppm (4.05). Whilst,lowest values of wateruse efficiency were produced from without foliar application of proline (3.92). Increasing proline concentration from 50,100 and 150 ppm increasedvalues of wateruse efficiencyduring 2013/2014 and 2015 seasons. **Cha-Um and Kirdmanee (2010)** reported that exogenous foliar-applied Glybet in optimum doses should be used as a short-term technique for the improvement of salt tolerance in rice and leading to improved water use efficiency and pigment stabilization.

3.9. Interaction effect between cuttings and proline concentrations foliar application effect:

With regard to the interaction effect between cuttings and proline concentrations foliar application on leaf area/plant (cm^2), the results in Table (28) revealed that this interaction significantly affected leaf area/plant (cm^2). The results showed that highest values of leaf area/plant (cm^2) was produced from the fourth cut and proline foliar application at 150 ppm (19.09 cm^2/plant). However, the lowest leaf area/plant (cm^2) was obtained from the third cut and without proline foliar application (16.59 cm^2/plant).

With respect to the interaction effect between cuttings and proline concentrations spraying on plant height (cm), the results in Table 1 clearly indicated that this interaction insignificantly affected plant height.

Regarding to the interaction effect between cuttings and proline concentrations foliar application on number of stems/m^2, the results showed in Table (29) clearly indicated that this interaction significantly affected average number of stems/m^2. Highest average number of stems/m^2 was produced from the fourth cut with foliar application of proline at 150 ppm without significant differences, which was 239.7 stems/m^2. On contrary, the lowest number of stems/m^2 war recoded from the first cut without proline foliar application (229.0 stems/m^2).

Fig.28: Averages of leaf area (cm^2) as affected by the interaction among cutting and proline concentrations during 2013/2014 and 2015 seasons.

Cuttings	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
1st cut	17.82	18.13	18.52	18.76
2nd cut	17.09	17.70	18.02	18.43
3rd cut	16.59	17.14	17.60	17.87
4th cut	17.97	18.37	18.75	19.09
5th cut	18.01	18.34	18.69	18.99
LSD at 5 %	0.23			

Fig.29: Averages of number of stems/m^2 as affected by the interaction between cutting and proline concentrations during 2013/2014 season.

Cuttings	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
1st cut	229.0	232.8	235.5	237.5
2nd cut	232.2	233.8	235.9	237.7
3rd cut	230.5	232.1	233.9	235.1
4th cut	233.1	235.5	237.9	239.7
5th cut	231.5	233.3	235.3	236.3
LSD at 5 %	0.8			

With respect to the interaction effect on forage green and dry matter yield/fed, the results in Table (1) clearly showed that the interaction between cuttings and proline concentrations foliar application insignificantly affected forage green and dry matter yield/fed.

Regarding to the interaction effect between cuttings and proline concentrations foliar application on percentages of crude fiber, ether extract, ash and nitrogen free extract as well as crude fiber, ether extract, ash and nitrogen free extract yield/fed, the results in Tables (2 and 3) clearly indicated insignificant effect on these traits during 2013/2014 and 2015 seasons.

3.10. Interaction effect between irrigation intervals and proline concentrations foliar application Effect:

Regarding to the interaction effect between cuttings, irrigation intervals and proline concentrations foliar application on total chlorophyll, the results in Table 1 showed insignificant effect due to this interaction on total chlorophyll.

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on leaf area (cm^2/plant), the results in Table (30) clearly showed that this interaction significantly affected leaf area (cm^2/plant). The results indicated that highest values of leaf area/plant (24.33 cm^2/plant) was produced from irrigation every 7 days and foliar application of proline at 150 ppm. However, the lowest values of leaf area/plant (11.59 cm^2/plant) was produced from irrigation every 14 days and without proline foliar application.

Fig.30: Averages of leaf area (cm^2) as affected by the interaction between irrigation intervals and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	**50 ppm**	**100 ppm**	**150 ppm**
Every 7 days	23.42	23.85	24.16	24.33
Every 14 days	11.59	12.03	12.48	12.93
LSD at 5 %	0.16			

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on plant height, the results in Table 1 showed this interaction insignificantly plant height.

Concerning to the interaction effect between irrigation intervals and proline concentrations foliar application on number of stems/m^2, the results in Table (31) revealed that highest number of stems/m^2 was produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (323.1 stems/m^2). Whilst, the lowest number of stems/m^2 was recorded from irrigation every 14 days and without proline foliar application (144.5 stems/m^2).

Fig.31: Averages of number of stems/m^2 as affected by the interaction among irrigation intervals and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	**50 ppm**	**100 ppm**	**150 ppm**
Every 7 days	318.0	319.3	321.9	323.1
Every 14 days	144.5	147.2	149.4	151.4
LSD at 5 %	0.52			

Concerning to the interaction effect between irrigation intervals and proline concentrations foliar application on forage green yield/fed, the results in Table (32) this interaction significantly affected forage yield (t/fed). The results revealed that highest forage green yield/fed was produced from irrigation every 7 days and proline foliar application at concentration of 150 ppm (3.217 t/fed). Whilst, the lowest forage green yield/fed was obtained from irrigation every 14 days and without proline foliar application (988 kg/fed).

Concerning to the interaction effect between irrigation intervals and proline concentrations foliar application on forage dry matter yield/fed, the results in Table (33) this interaction significantly affected forage dry matter yield/fed. The results revealed that highest forage dry matter yield/fed was produced from irrigation every 7 days and proline foliar application of proline at concentration of 100 or 150 ppm without significant differences, which were 2.077 and 2.076, respectively. Whilst, the lowest forage dry matter yield/fed was obtained from irrigation every 14 days and without proline foliar application or proline foliar application of proline at concentration of 50 ppm without significant differences, which were 641 and 652 kg/fed, respectively.

Fig.32: Averages of forage green yield (ton/fed) as affected by the interaction between irrigation intervals and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	3.147	3.174	3.192	3.217
Every 14 days	0.988	1.000	1.009	1.015
LSD at 5 %	0.068			

Fig. 33: Averages of dry forage yields ton/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of fife cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	2.016	2.042	2.077	2.076
Every 14 days	0.641	0.652	0.660	0.667
LSD at 5 %	0.022			

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on water use efficiency, results presented in Table 34 clearly revealed a significant effect due to this interaction on water use efficiency during 2013/2014 and 2015 seasons. The results revealed that highest values of water use efficiency were produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (4.93). Whilst, the lowest forage dry matter yield/fed was obtained from irrigation every 14 days and without proline foliar application (3.04).

With respect to the interaction effect between irrigation intervals and proline concentrations foliar application on ash percentage, results presented in Table 35 clearly revealed a significant effect due to this interaction on ash percentage during 2013/2014 and 2015 seasons. The results revealed that highest ash percentage was produced from irrigation every 14 days and proline foliar application of proline at concentration of 150 ppm (12.45%). Whilst, the lowest ash percentage was obtained from irrigation every 7 days and without proline foliar application (10.93).

Fig. 34: Averages of water use efficiency as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	4.79	4.85	4.89	4.93
Every 14 days	3.04	3.09	3.13	3.16
LSD at 5 %	0.03			

Fig. 35: Averages of ash percentage as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	10.75	11.10	11.47	11.79
Every 14 days	10.93	11.25	11.74	12.15
LSD at 5 %	0.10			

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on crude protein and fiber, ether extract and nitrogen free extract percentages, the results in Table 1 showed this interaction insignificantly affected crude fiber, ether extract and nitrogen free extract percentages during 2013/2014 and 2015 seasons.

Concerning to the interaction effect between irrigation intervals and proline concentrations foliar application on crude protein yield/fed, results presented in Table (36) clearly revealed a significant effect due to this interaction on crude protein yield/fed during 2013/2014 and 2015 seasons. The results revealed that highest crude protein yield/fed was produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (282.4 Kg/fed). Whilst, the lowest crude protein yield/fed was obtained from irrigation every 14 days and without proline foliar application (82.08 Kg/fed).

Fig. 36: Averages of crude protein yield Kg/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	259.6	265.2	274.1	282.4
Every 14 days	82.08	84.86	87.12	91.2
LSD at 5 %	3.7			

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on crude fiber yield/fed, results presented in Table (37) clearly revealed a significant effect due to this interaction on fiber protein yield/fed during 2013/2014 and 2015 seasons. The results revealed that highest fiber protein yield/fed was produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (564.2 Kg/fed). Whilst, the lowest fiber protein yield/fed was obtained from irrigation every 14 days and without proline foliar application (166.7 Kg/fed).

Fig. 37: Averages of crude fiber yield Kg/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	517.0	536.5	549.8	564.2
Every 14 days	166.7	173.3	179.1	183.8
LSD at 5 %	6.2			

With respect to the interaction effect between irrigation intervals and proline concentrations foliar application on ether extract yield/fed, results presented in Table (38) clearly discovered a significant effect due to this interaction on ether extract yield/fed during 2013/2014 and 2015 seasons. The results revealed that highest ether extract yield/fed was produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (206.6 Kg/fed). Whilst, the lowest ether extract yield/fed was obtained from irrigation every 14 days and without proline foliar application (11.9 Kg/fed).

Fig. 38: Averages of ether extract yield Kg/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	173.5	191.6	203.5	206.6
Every 14 days	11.9	12.0	12.9	13.2
LSD at 5 %	8.0			

Regarding to the interaction effect between irrigation intervals and proline concentrations foliar application on ash yield/fed, results presented in Table (39) clearly exposed a significant effect due to this interaction on ash yield/fed during 2013/2014 and 2015 seasons. The results revealed that highest ash yield/fed was produced from irrigation every 7 days and proline foliar application of proline at concentration of 150 ppm (236.4 Kg/fed). Whilst, the lowest ash yield/fed was obtained from irrigation every 14 days and without proline foliar application (67.0 Kg/fed).

With respect to the interaction effect between irrigation intervals and proline concentrations foliar application on nitrogen free extract yield/fed, results presented in Table (40) clearly exposed a significant effect due to this interaction on nitrogen free extract yield/fed during 2013/2014 and 2015 seasons. The results revealed that highest nitrogen free extract yield/fed was produced from irrigation every 7 days and without proline foliar application (1002.0 Kg/fed). Whilst, the lowest nitrogen free extract yield/fed was obtained from irrigation every 14 days and proline foliar application at 100 or 150 ppm (300.1 Kg/fed) without significant differences.

Fig. 39: Averages of ash yield Kg/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	208.3	217.7	227.6	236.4
Every 14 days	67.0	70.3	74.8	77.7
LSD at 5 %	2.9			

Fig. 40: Averages of nitrogen free extract Kg/fed as affected by the interaction between irrigation intervals and proline concentrations, as average of five cuts during 2013/2014 and 2015 seasons.

Irrigation intervals	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Every 7 days	1002.0	986.0	968.9	950.2
Every 14 days	314.2	310.2	306.3	300.1
LSD at 5 %	8.3			

Regarding to the interaction effect between forage species and proline concentrations foliar application on average of total chlorophyll, the results in Table (41) clearly indicated that this interaction significantly affected total chlorophyll. The results indicated that highest total chlorophyll was obtained from sowing Rhodes grass and proline foliar application concentrations of 100 or 150 ppm without significant differences, which were 17.57 and 17.88, respectively. While, the lowest total chlorophyll values were produced from sowing Blue panic grass without proline foliar application (12.65).

Fig.41: Averages of total chlorophyll (SPAD) as affected by the interaction between forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	16.78	16.93	17.57	17.88
Rhodes grass	14.88	15.10	15.63	15.96
Blue panic grass	12.65	12.97	13.48	14.07
LSD at 5 %	0.15			

3.11. Interaction between forage species and proline concentrations foliar application effect:

Regarding the interaction effect among forage species and proline concentrations foliar application on leaf area/plant (cm^2) and plant height (cm), the results in Table 1 showed insignificant effect due to this interaction on leaf area/plant (cm^2) and plant height (cm).

With respect to the interaction effect between forage species and proline concentrations foliar application on number of stems/m^2, the results in Table (42) showed that this interaction significantly affected number of stems/m^2. The results indicated that sowing Rhodes grass and proline foliar application at concentration of 150 ppm produced highest number of stems/m^2 (340.1 stems/m^2). However, the lowest number of stems/m^2 (128.3 stems/m^2) was obtained from sowing alfalfa and without proline foliar application.

Fig.42: Means of number of stems/m^2 as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	128.3	130.3	131.8	133.5
Rhodes grass	332.3	335.8	338.5	340.1
Blue panic grass	232.9	234.4	236.7	238.1
LSD at 5 %	0.6			

With respect to the interaction effect between forage species and proline concentrations foliar application on forage green and dry matter yield/fed, the results in Table 1 indicated that this interaction insignificantly affected forage green and dry matter yield/fed.

Concerning to the interaction effect between forage species and proline concentrations foliar application on water use efficiency, the results in Table (43) showed that this interaction significantly affected water use efficiency. The results indicated that sowing Rhodes grass and proline foliar application at concentration of 150 ppm produced highest water use efficiency (5.97). However, the lowest water use efficiency (2.08) was obtained from sowing alfalfa and without proline foliar application.

Fig.43: Means of water use efficiency as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	2.08	2.12	2.15	2.16
Rhodes grass	5.82	5.89	5.93	5.97
Blue panic grass	3.84	3.91	3.96	4.01
LSD at 5 %	0.04			

Regarding to the interaction effect between irrigation intervals and concentrations of proline foliar application on percentages of crude protein and fiber, the results in Tables (2) clearly indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Concerning to the interaction effect between forage species and proline concentrations foliar application on ether extract percentage, the results in Table (44) showed that this interaction significantly affected ether extract percentage. The results indicated that sowing Alfalfa and proline foliar application at concentration of 150 ppm produced highest ether extract percentage (2.33%). However, the lowest ether extract percentage (1.57%) was obtained from sowing Blue panic grass and without proline foliar application.

Fig.44: Means of ether extract percentage as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	2.16	2.27	2.28	2.33
Rhodes grass	1.65	1.79	1.90	1.91
Blue panic grass	1.57	1.65	1.78	1.83
LSD at 5 %	0.07			

With respect to the interaction effect between forage species and proline concentrations foliar application on ash percentage, the results in Table (45) showed that this interaction significantly affected ash percentage. The results indicated that sowing Alfalfa and proline foliar application at concentration of 150 ppm produced highest ash percentage (13.58%). However, the lowest ash percentage (9.74%) was obtained from sowing Rhodes grass and without proline foliar application.

Fig.45: Means of ash percentage as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	**50 ppm**	**100 ppm**	**150 ppm**
Alfalfa	12.55	12.78	13.18	13.58
Rhodes grass	9.74	9.97	10.52	10.88
Blue panic grass	10.23	10.77	11.11	11.50
LSD at 5 %	0.17			

Concerning to the interaction effect between forage species and proline concentrations foliar application on crude protein yield/fed, the results in Table (46) showed that this interaction significantly affected crude protein yield/fed. The results indicated that sowing Rhodes grass and prolinefoliar application at concentration of 150 ppm produced highest crude protein yield/fed (242.3 Kg/fed). However, the lowest crude protein yield/fed was obtained from sowing Alfalfa and without proline foliar application or proline foliar application at concentration of 50 ppm without significant differences, which were 131 and 134.9 Kg/fed, respectively.

Fig.46: Means of crude protein yield/fed as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	**50 ppm**	**100 ppm**	**150 ppm**
Alfalfa	131.1	134.9	138.0	142.1
Rhodes grass	225.8	230.3	234.9	242.3
Blue panic grass	155.8	159.9	169.0	176.2
LSD at 5 %	4.6			

Regarding to the interaction effect between forage species and proline concentrations foliar application on crude fiber yield/fed, the results in Table (47) showed that this interaction significantly affected crude fiber yield/fed. The results indicated that sowing Rhodes grass and proline foliar application at concentration of 150 ppm produced highest crude fiber yield/fed (535.8 Kg/fed). However, the lowest crude fiber yield/fed was obtained from sowing Alfalfa and without proline foliar application (110 Kg/fed).

Fig.47: Means of crude protein fiber yield/fed as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	110.0	117.9	121.4	125.3
Rhodes grass	498.0	409.9	521.8	535.8
Blue panic grass	417.6	437.0	450.1	460.9
LSD at 5 %	7.6			

With respect to the interaction effect between forage species and proline concentrations foliar application on ether extract yield/fed, the results in Table (48) showed that this interaction significantly affected ether extract yield/fed. The results indicated that sowing Rhodes grass and proline foliar application at concentration of 100 or 150 ppm produced highest ether extract yield/fed without significant differences, which were 284.3 and 287.9, respectively. However, the lowest ether extract yield/fed was obtained from sowing Alfalfa and without or proline foliar application at 50, 100 and 150 ppm without significant differences, which were 15.2, 16.2, 16.5 and17.3 Kg/fed, respectively.

Regarding to the interaction effect between forage species and proline concentrations foliar application on ash yield/fed, the results in Table (49) showed that this interaction significantly affected ash yield/fed. The results indicated that sowing Rhodes grass and proline foliar application at concentration of 100 or 150 ppm produced highest ash yield/fed (215.3 Kg/fed). However, the lowest ash yield/fed was obtained from sowing Alfalfa and without proline foliar application (89.7 Kg/fed).

Fig.48: Means of ether extract yield/fed as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	15.2	16.2	16.5	17.3
Rhodes grass	241.4	267.4	284.3	287.9
Blue panic grass	20.5	21.9	23.7	24.7
LSD at 5 %	9.9			

Fig.49: Means of ash yield/fed as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	89.7	92.4	96.0	98.7
Rhodes grass	190.2	195.7	206.8	215.3
Blue panic grass	133.2	144.0	185.8	157.2
LSD at 5 %	0.9			

With respect to the interaction effect between forage species and proline concentrations foliar application on nitrogen free extract yield/fed, the results in Table (50) showed that this interaction significantly affected nitrogen free extract yield/fed. The results indicated that sowing Rhodes grass and without proline foliar application produced highest nitrogen free extract yield/fed (1017.0 Kg/fed). However, the lowest nitrogen free extract yield/fed was obtained from sowing Alfalfa and foliar application of proline at 150 ppm (355.1 Kg/fed).

Fig.50: Means of nitrogen free extract yield/fed as affected by the interaction among forage species and proline concentrations, as average of three cuts, during 2013/2014 and 2015 seasons.

Forage species	Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm
Alfalfa	366.3	363.8	360.7	355.1
Rhodes grass	1017.0	1002.0	984.1	862.9
Blue panic grass	591.2	578.5	567.9	557.5
LSD at 5 %	7.7			

3.12Interaction effect between cuttings, irrigation intervals and proline concentrations foliar application effect:

Regarding to the interaction effect between cutting, irrigation intervals and proline concentrations foliar application on average of total chlorophyll, the results in Table (51) clearly indicated that this interaction significantly affected average total chlorophyll. The results clearly showed that highest values of total chlorophyll (19.03) was produced from the fifth cut and treatment irrigated every 7 days and foliar application of proline at concentration of 150 ppm. However, the lowest values of total chlorophyll were recorded from the third or second cut when irrigated every 14 days and without foliar application of proline without significant differences, which were 11.81 and 11.56, respectively.

Fig. 51: Total chlorophyll (SPAD) as affected by the interaction between cuttings, irrigation intervals and proline concentration during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals							
	Every 7 days				Every 14 days			
	Proline concentrations				Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm	0 ppm	50 ppm	100 ppm	150 ppm
1st cut	17.84	17.92	18.48	18.85	11.91	12.15	12.60	13.16
2nd cut	17.56	17.85	17.40	18.71	11.81	12.27	12.85	13.35
3rd cut	17.01	17.25	17.93	18.21	11.56	11.93	12.55	13.01
4th cut	17.84	17.92	18.48	18.85	11.91	12.15	12.35	12.60
5th cut	18.11	18.17	18.70	19.03	12.15	12.35	13.00	13.34
LSD 5 %	0.44							

With respect to the interaction effect between cuttings, irrigation intervals and proline concentrations foliar application on leaf area/plant (cm^2) and plant height (cm), the results in Table 1 clearly showed that this interaction insignificantly affected leaf area/plant (cm^2) and plant height (cm).

With respect to the interaction effect between cuttings, irrigation intervals and proline concentrations foliar application on average number of stems/m^2, the results presented in Table (52) clearly indicated that this interaction significantly affected average number of stems/m^2. The results indicated that first cut and irrigation every 7 days and proline foliar application at connotations of 150 ppm produced highest stem number/m^2 (327.6 stems/m^2). However, the lowest number of stems/m^2 was obtained from the third cut and irrigation every 14 days without proline foliar application (145.9 stems/m^2).

With respect to the interaction effect between cuttings, irrigation intervals and concentrations of proline foliar application on forage green and dry matter yield/fed., the results in Table 1 clearly showed that this interaction insignificantly affected forage green and dry matter yield/fed.

Regarding to the interaction effect between cuttings, irrigation intervals and concentrations of proline foliar application on percentages of crude protein and fiber, ether extract ash and nitrogen free extract and yield/fed of crude protein and fiber, ether extract ash and nitrogen free extract, the results in Tables (2and 3) clearly indicated that this interaction insignificantly affected these traits during 2013/2014 and 2015 seasons.

Fig. 52: Average number of stems/m^2 as affected by the interaction among cuttings, irrigation treatments and proline concentration during 2013/2014 and 2015 seasons.

Cuttings	Irrigation intervals							
	Every 7 days				Every 7 days			
	Proline concentrations				Proline concentrations			
	0 ppm	50 ppm	100 ppm	150 ppm	0 ppm	50 ppm	100 ppm	150 ppm
1st cut	313.0	314.3	316.6	317.3	144.9	151.2	154.5	157.8
2nd cut	319.8	321.0	323.0	324.4	144.5	146.5	148.8	150.9
3rd cut	317.7	319.4	321.3	322.6	143.4	144.8	146.5	147.6
4th cut	320.8	323.6	326.1	327.6	145.3	147.5	149.7	151.8
5th cut	318.5	320.6	322.8	323.8	144.4	145.9	147.8	148.7
LSD 5 %	1.2							

3.13. Interaction between cuttings, forage species and proline concentrations foliar application effect:

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

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

3.14. Interaction between irrigation intervals, forage species and proline concentrations foliar application effect:

With respect to the interaction effect between irrigation intervals, forage species and proline concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, fresh and dry forage yield/fed, the results in Table 1 clearly showed insignificant due to this interaction on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, fresh and dry forage yield/fed.

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

3.15. Interaction between cuttings, irrigation intervals, forage species and proline concentrations foliar application effect:

Concerning to cuttings, irrigation intervals, forage species, proline concentrations foliar application on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, fresh and dry forage yield/fed, the results presented in Table 1 clearly showed that insignificant effect due to this interaction on total chlorophyll, leaf area/plant (cm^2), plant height (cm), number of stems/m^2, fresh and dry forage yield/fed.

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

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