Productivity and Physiological Response of Fodder Beet to Drip Irrigation Regimes and Potassium Levels Under Calcareous Soil Conditions

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ABSTRACT

A field trait was conducted at Nubaria Agricultural Research Station, EL-Behira Governorate, Egypt during two winter successive growing seasons of 2013/2014 and 2014/2015 on fodder beet (Beta vulgaris L.) variety Voro-shenger. The aim was to study the effect of three drip irrigation regimes i.e. Irrigation with amount of water equal 100% (I1), 80% (I2) and 60 %(I3) of potential evapotranspiration (ETp) and potassium fertilization at rates of 0, 57.12, 114.24 and 171.36 Kg K2O/ha.

Results of combining analysis revealed that increasing irrigation levels led to significant increase in crop growth rate (CGR) at (90-120) and (120-150) DAS, leaves and root fresh weight Kg/plant, leaves and root dry weight g/plant, root length and diameter as well as root, total yield ton/ha and total chlorophyll of leaves. Dry treatments significantly reduced the percentage of potassium (K %), crud protein (CP %), digestive crud protein (DCP %) and crud fiber (CF %). Whereas, the percentage of total soluble solid (TSS %) and total digestible nutrients (TDN %) significantly increased. The maximum percentage of Relative water content (RWC %) was obtained from wet treatment, while medium treatment at 80% of ETp give the maximum values of water utilization efficiency (WUtE).

Adding 171.36 KgK_2O/ha significantly increased CGR at (90-120) and (120-150) DAS, Leaves fresh weight Kg/plant, leaves and root dry weight, root length and diameter, root and foliage yields as well as total yield ton/ha, total chlorophyll of leaves, DCP% and K%. While adding 171.36 and 114.3 KgK_2O/ha significantly increased root fresh weight Kg/plant, CP% and CF% with insignificant difference. However, TDN% decreased by increasing potassium fertilization. Maximum RWC% and WUtE were obtained when plants received 171.36 KgK2O/ha.

The interaction between irrigation regimes and potassium fertilization levels had significant effect on all traits under study except CGR at (90-120) DAS, root diameter, foliage yield ton/fed, total chlorophyll of leaves, K% and TSS%. The highest values of CGR (120-190), Leaves Fresh weight Kg/plant, leaves and root dry weight g/plant, CP%, CF% as well as DCP% and RWC were achieved from wet treatment (100% of ETp) in combination with 171.36 KgK_2O/ha. While irrigation with 100%, 80% of ETp and 171.36 KgK_2O/ha gave the highest values for root length, root and total yield ton/ha as well as WUtE with insignificant difference. However irrigation with 100% of ETp combined with 114.24 and 171.36 have the highest values for root fresh weight Kg/plant with insignificant difference. The maximum TDN% obtained from dry treatment (60% of ETp) without potassium fertilization.

According to profitability assessment, the highest net income and investment ratio as an average of two growing seasons were obtained when plants watered by amount of water equal 80% of ETp and received 171.36 KgK_2O/ha.

Keywords: Fodder beet- Regime irrigation- Potassium levels- Growth- Forage yields and quality- Water utilization efficiency.

INTRODUCTION

Fodder beet (*Beta vulgaris,* L) is one of the most promising winter forage crop in Egypt. It is and ideal fodder for dairy cows due to its high nutritive value, high dry matter yield, good source of carbohydrates, high palatability and digestibility. Moreover, it is adapted to saline, calcareous soils and requires less water compared to other forage crops. The whole yield, i.e; above and underground parts, can directly be used in feedings, or may be processed as silage. The roots can also be stored in soil without great damage. Thus, its cultivation may help in overcoming the problem of animal feeding during summer season.

Water stress is a major condition that affect crop productivity. Water is an integral part of plant, plays a vital role in the maintenance of plant life. The deficiency of water modifies soil-plant water relationship by lowering tissue water potential and impairing metabolic processes, (Akhtar *et al* 1993). Currently, water is a primary limiting factor in Egyptian agriculture to address efforts to the fundamental issue of increasing crops production, while reducing their water consumption, especially in reclaimed lands. This might be achieved through an effective use of modern irrigation techniques. Several investigation studied the effect of water stress on fodder beet growth. Hussein and Siam, Hanan (2014) pointed that the least fresh roots or tops yields were obtained when plants subjected to drought by withholding the 2nd irrigation, while, the least tops, roots and total dry yields were obtained when plants subjected to drought by withholding the 4th irrigation. Also, Sakr et al (2014) stated that, water stress during maturity stage through withholding last, two or last three irrigation markedly reduced forage yields and its components as well as crude protein (CP%), crude fiber(CF%), potassium (K%) and digestible crude protein (DCP%). In contrary, gradual increases in total soluble solids (TSS %) and total digestible nutrients (TDN %) were resulted from irrigation withholding treatments.

With increasing demands on limited water resources and the need to minimize adverse environmental consequences of irrigation, drip irrigation technology will undoubtedly play an important role in the future of the Egyptian agriculture. Application of uniform and sufficient water for good crop establishment is one of the most challenge issues of subsurface drip irrigation (Camp, 1998).

Most cultivated crops experience one or more abiotic stresses of some type throughout their growth stages. Thus, increasing plant resilience in response to abiotic stress is great challenge in the effort to improve plant production. Improving plant tolerance to drought is achieved by applying potassium which is vital for plant survival under water stress conditions. Moreover, potassium plays significant regulatory roles in osmoregulation, water movement, cation-anion balance, enzymatic activation, as well as activating antioxidant defense system.

A close relationship between the potassium nutritional status and fodder beet plant drought resistance has been demonstrated. Bahuri, *et al* (2003). They studied the effect of different irrigation water and different potassium levels on fodder beet yield and yield components in sandy soil under drip irrigation. Results showed that, fodder beet yield increased by increasing irrigation water and potassium rats. The fresh roots yield increased by 17.1 and 19.8% with increasing applied water to 2300 and 2760 m^3/fed., respectively compared with 1840 m^3/fed. Potassium fertilizer mitigates the adverse effects of drought on plant growth. Kassab *et al*, 2012, suggested that foliar potassium (K) spray of 1 Kg/fed gave the highest values of growth and yield parameters as well as water use efficiency (WUE) in both seasons. Also, the interaction between irrigation regimes and K fertilizer was significant in most growth and yield parameters.

The present investigation was carried out to study the physiological response of fodder beet plant to three drip irrigation water regimes in combination with different levels of potassium fertilization on growth, productivity, forage quality, as well as water utilization efficiency under calcareous soils conductions of Nubaria region.

MATERIALS AND METHODS

A field experiments was conducted during the two successive winter seasons of 2013/2014 and 2014/2015 at Nubaria Agricultural Research Station , EL-Behiera governorate, Egypt, using fodder beet variety *Voroshenger* to study the effect of surface drip irrigation and potassium fertilization levels and their interaction on growth, productivity and forage quality. The experiment was laid out in a strip-plot design with three replicates. The vertical plots were assigned to three irrigation treatments and the horizontal plots were occupied by four potassium fertilization rates. The used surface drip irrigation system in the experimental farm included an irrigation pupm connected to sand and screen filters and a fertilizer injector tank. Main line is made of PVC pipe of 63mm diameter, while drip lateral lines of 16 mm diameter were connected to the main lines. Each lateral is 25m long and 0.5m spacing. Standard emitters of 4.0 L/h discharge were spaced 0.3m apart on the lateral line. Each experimental plot contend four lateral lines. Drip irrigation efficiency parameters including Christiansen coefficient and emission uniformity were determined. The values of these parameters were 94% and 92% respectively. The measured emitter average discharge rate was 3.52 L/h. Fodder beet seeds were planted on 30th October, 2013 and 13th October, 2014 in the first and second seasons, respectively. Plants were thinned to one plant per hill after 30 days from sowing. Mono super phosphate 15.5% P_2O_5 was added at the rate of 71.4 Kg P_2O_5/ha and incorporate to soil before sowing. All plots received 142.8 Kg nitrogen (N)/ha (as ammonium nitrate, 33.5% N) through the irrigation system (Fertigation). Also potassium fertilizer levels (0, 57.12, 114.24 and 171.36 Kg/ha) in the form of potassium sulphate (48% K_2O) were injected. The irrigation treatments were: 100%, 80% and 60% of potential evapotranspiration (ET_P) and determined by class a pan. To determine growth traits, five plants were randomly taken from each plot at 90, 120 and 150 days from sowing (DAS). In each sample, plants were separated to their components i.e.; leaves and roots, then dried at 60˚C for 48 h in a ventilated oven or until constant weight to determine crop growth rate (CGR) at (90-120) and (120-150) DAS in g/plant/week according to Watson (1952)

Calculated as: $\mathbf{CGR = (W_2 - W_1) / (T_2 - T_1)}$

Where; $(W_2 - W)_1$= differences in dry mater accumulation between two successive samples in grams and $(T_2 - T_1)$ = the number of days between two successive samples in week.

At 100 DAS total chlorophyll of leaves (mg/m^2) was determined as SPAD unit using SPAD 502 apparatus (Soil and plant Analysis Departments of Minolta Co.) This unit was transformed to mg/m^2 as described by Mong and Bugbe (1992) as follows:

Chl. = 80.05+10.4(SPAD 502).

At harvest (200-202 days from sowing) ten guarded plants were randomly chosen from each plot to determine root length/plant (cm), root diameter/ plant (cm), root fresh weight(Kg/plant) , foliage fresh weight (Kg/ plant), root yield (ton/ha), foliage yield (ton/ha) and total yield (ton/ha). Total soluble solids (TSS %) in roots was measured in juice of fresh roots by using Hand Refract meter. Roots samples were chopped into 1-2 cm pieces and thoroughly mixed, a 300 g sample of fresh chopped roots was dried in an oven at 40°C for 2 days and at 70°C for 3 days. The dried samples were chemically analyzed for crude protein (CP %) and crude fiber (CF %) according to A.O.A.C., 1990. Potassium content in roots was determined using flame photometer as described by Peterburgski (1968). Digestible crude protein (DCP %) and total digestible nutrients (TDN %) were calculated according to Church (1979).At 100 days after sowing, leaf samples were immediately weighed (fresh weight, (Fw)) and transferred into sealed flasks, then rehydrated in water for 5 h until fully turgid, surface swabbed and reweighed (turgid weight, (Tw)). Leaf samples were oven dried at 70C for 48 h and reweighed (dry weight, (Dw)). Relative water content (RWC) of leaves (%) was calculated according to Lazcano-Ferrat and Lovatt (1999) as follows:

RWC %=((Fw - Dw)/ (Tw- Dw)) X (100)

Soil chemophysical characters of the experimental site were determined according to Black (1965). Soil texture for the surface 0-60 cm. depth was sandy clay loam (60% sand, 19.1% silt and 20.9% clay), soil pH = 8.4, O.M. = 0.3%, total CaCO3% = 31.8%, EC= 1.341 ds m^{-1}. Soil baulk density (BD) = 1.21 g/cm^3. Soil field capacity (F.C) and wilting points (WP) were determined by a pressure extractor apparatus (LAB 023 LABORATORY) and available soil moisture (ASM) values were calculated and presented in Table (1).

Table 1: Field capacity, wilting point, available water and soil bulk density a mean of the two experimental seasons at Nuburia Agric. Res – Station farm.

Soil depth (cm)	Field capacity (%)	Wilting points (%)	Available water (%)	Bulk density (g/cm^3)
0-15	24.6	13.53	11.37	1.17
15-30	24.7	13.42	11.28	1.20
30-45	23.9	12.99	10.91	1.22
45-60	23.6	12.83	10.77	1.25
Means	24.27	13.19	11.08	1.21

Monthly potential evapotranspiration (ET_P) values measured by class a pan at the experimental site for the I_1 (100%ET_P) irrigation treatment and presented in Table (2). Results showed that monthly ET_P values started low during December, January and February and increased to maximum values during May for the both seasons.

Table 2: Potential evapotranspiration ETp (mm/month) and (mm/day). Values for the 2013/14and 2014/15seasons

Month	2013/14		2014/15	
	mm/month	mm/day	mm/month	mm/day
Oct.	-	-	64.6	2.08
Nov.	59.1	1.97	72.0	2.40
Dec.	46.5	1.50	55.8	1.8
Jan.	38.75	1.25	46.5	1.5
Feb.	44.95	1.55	55.1	1.9
Mar.	72.13	2.40	89.9	2.9
Apr.	108.0	3.60	135.0	4.5
May.	132.6	4.42	162.0	5.4
Jun.	71.25	2.38	-	-
Total mm	573.28	-	680.90	-

The amounts of applied irrigation water (AIW) by drip irrigation system to the fodder beet according to the irrigation treatments for the two growing seasons are presented in Table (3) according to Doerenbos and Kassam (1979) and James (1998).

Results indicated that the amount of applied water values were 5305.07, 4243.78 and 3183.04 m^3/ha. In the first season, while it were 5514.79, 4412.23 and 3529.59 m^3/ha. In the second season for the irrigation treatments 100, 80 and 60 % ET_P, respectively. At the beginning of the season the amount of applied water was low and increased after this due to increasing the vegetative growth of fodder beet that covered the soil surface. The highest values of water applied under irrigation treatment (100% ET_P) due to evaporation from the soil surface increased at high moisture content as well as supplying plants with sufficient moisture led to increase green cover which increase transpiration.

Table (3) Amount of applied water (mm) as affected by irrigation regimes during 2013/14 and 2014/15 growing seasons.

Month	2013/14			2014/15		
	100%Etp	80%Etp	60%Etp	100%Etp	80%Etp	60%Etp
Oct.	-	-	-	46.90	37.52	22.51
Nov.	58.48	46.78	35.09	59.36	47.49	28.49
Dec.	44.565	35.65	26.74	44.48	35.58	21.35
Jan.	37.08	29.66	22.25	36.96	29.57	17.74
Feb.	46.08	36.86	27.65	47.92	38.34	23.0
Mar	71.28	57.02	42.77	71.68	57.34	34.4
Apr.	106.80	85.44	64.08	111.16	88.93	53.36
May	131.2	104.96	78.72	133.28	106.62	63.97
Jun.	35.24	28.19	21.14	-	-	-
Total mm	530	424.56	318.43	551.7	441.39	353.11
m^3/ ha	5305.07	4243.78	3183.04	5514.79	4412.23	3529.59

Water utilization efficiency (WU_tE) was calculated according to Jensen (1983). To assess and compare of farm profitability of all tested variables the total input, output and investment ratios were calculated.

Statistical analysis data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip plots design as described by Steel and Torrie (1980). Least significant difference (L.S.D) method used to test the differences between treatment means at 5% level of probability as described by Snedecor and Cochran (1980). Meanwhile, the combined analysis of variance was performed for the data of the two seasons after tested the homogeneity of error by Bartlett's test (Steel and Torrie 1980). The processes of the analyses were carried out, using SAS program (SAS 2014).

RESULTS AND DISCUSSION

Crop Growth Rate (CGR):

Data in Table (4) and Fig (1) indicated that both soil moisture stress and potassium fertilization had significant effects on CGR at the first period (90-120 DAS) and the second period (120-150 DAS). Maximum values of such trait were obtained from the wet treatment, which was watered with amount of water equals 100% of potential evapotranspiration (ETp).However, the minimum values were obtained from dry treatment (irrigation with amount of water equals 60% of potential evapotranspiration (ETp) in the both seasons and combining analysis). These finding may be due to the importance of water to dry matter accumulation or formation of photosynthesiate compounds, (Abdo, Fatma and Anton 2009). Moreover, it was suggested that, at the cellular level drought stress causes shrinkage of cells, cell-membrane injury, and production of free radicals that cause damage to the cellular apparatus, (Terbea *et al*, 1995 and Sgherri *et a*l,1996).Similar results were obtained by Mary Henen (2011) on sunflower plants.

Regarding the effect of potassium fertilization, adding 171.36 KgK_2O /ha significantly increased CGR at the two period under study in the both seasons and combining analysis. Such finding was attributed to significant regulatory roles of K in numerous plant physiological processes via, stomatal regulation, photosynthesis, nutrient balance and dry matter accumulation (.Marschner, 2012).

Significant interaction between water treatment and potassium fertilization was expressed for CGR at the second period under this study in both seasons and combining analysis.Plants irrigated with amount of water equals 100% of ET_p and received 171.36 Kg K_2O/ha gives the highest values.

Root length and Diameter (cm)

Data of table (4) and (Fig 2) showed that, water deficit decreased significantly root length of fodder beet plant. Such results can be explained on the bases that under surface drip irrigation system, water in the surface layer was available and roots may absorb water in easy way. On the other hand, Miseha *et al*. (1992) and, Anton *et al* (1995) found that water stress increased root length of fodder beet plants under surface irrigation system. The same trend was found for root diameter. Such data revealed that deficiency of soil water, limits root growth and functioning.

Table (4) and (Fig2) showed that increasing potassium fertilization up to 171.36 KgK_2O/ha increased significantly root length and root diameter in both seasons and combining analysis. Such results may prove the important of potassium for those crops which store carbohydrates like fodder beet plants. Also, Romheld and Kirk (2010) suggested that, increasing root growth by applying K, increases the root surface area under drought conditions, which ultimately enhances the water uptake by plant cells.

There was significant effect due to the interaction between irrigation treatments and potassium fertilization levels on root length in both seasons and combining analysis as shown from results in table (4) and (Fig 2). The highest values were obtained from plants irrigated with 100% and 80% of (ET_p)) and received 171.36 KgK_2O/ha with insignificant difference. While root diameter did not affect by the interaction between irrigation treatments and potassium fertilization leaves

Table (4): Effect of irrigation regimes and potassium levels on CGR (g/plant/week) at (90-120 DAS) and (120-150DAS), Root length (cm) and Root diameter (cm) in 2013/14 and 2014/15 seasons.

Treatments		CGR g/plant/week) (90-120 DAS)		CGR g/plant/week) (120-150 DAS)		Root length(cm)		Root diameter(cm)	
Irrigation regimes	Potassium levels Kg/ha	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
I_1	0	4.81	5.01	11.26	11.98	35.97	39.60	13.20	14.33
	57.12	5.60	5.96	13.41	14.88	37.77	44.17	14.50	15.00
	114.24	7.39	8.05	16.40	16.90	39.40	44.40	14.83	15.00
	171.36	9.32	9.74	20.33	22.60	45.13	49.13	15.50	16.16
	Mean	6.78	7.19	15.35	16.59	39.57	44.32	14.51	15.25
I_2	0	4.36	4.80	10.90	11.02	27.17	35.67	11.66	11.00
	57.12	5.41	5.81	12.88	14.10	35.20	40.37	13.00	12.00
	114.24	7.26	7.88	15.76	15.88	40.53	45.60	13.10	14.66
	171.36	9.21	9.61	19.63	20.40	43.40	48.23	13.83	14.67
	Mean	6.56	7.02	14.79	15.35	36.57	42.57	12.87	13.08
I_3	0	3.91	4.12	9.88	10.33	20.10	36.00	9.66	10.00
	57.12	5.06	5.20	10.41	12.26	23.97	39.97	10.16	10.83
	114.24	7.07	7.60	14.60	15.20	26.80	41.57	10.00	11.50
	171.36	8.96	9.31	18.67	19.33	28.23	42.37	11.83	12.83
	Mean	6.25	6.55	13.39	14.30	24.77	39.98	10.41	11.21
Potassium levels 0 Kg/ha		4.36	4.64	10.68	11.11	27.74	37.09	11.50	11.77
Potassium levels 57.12Kg/ha		5.35	5.65	12.23	13.74	32.31	41.50	12.55	12.61
Potassium levels 114.24 Kg/ha		7.24	7.84	15.58	16.03	35.58	43.86	12.64	13.72
Potassium levels 171.36Kg/ha		9.16	9.55	19.54	20.77	38.92	46.57	13.72	14.55
$LSD_{(0.05)}$ I		0.15	0.11	0.33	0.247	2.13	2.86	1.63	1.32
$LSD_{(0.05)}$ K		0.12	0. 09	0.30	0.219	2.01	2.57	1.51	1.26
$LSD_{(0.05)}$ I *K		NS	NS	0.50	0.320	3.05	3.99	NS	NS

Irrigation treatment: I1, I2, & I3 = 100, 80, &60% potential evapotranspiration (ETp) class A pan.

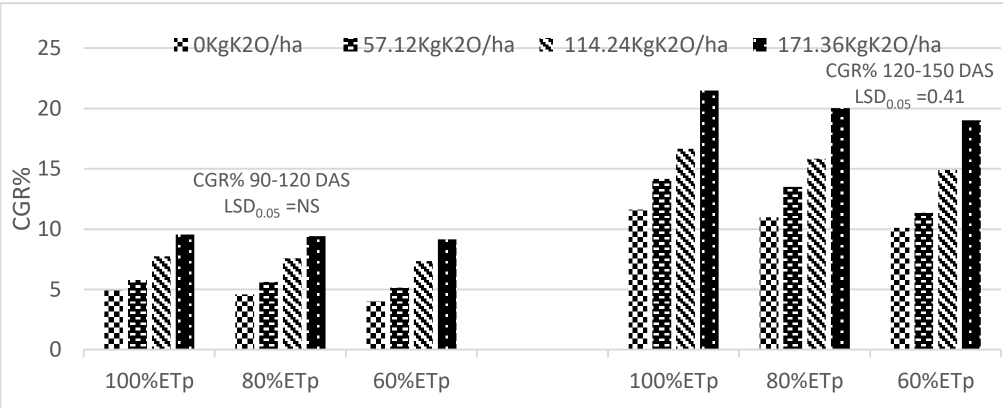

Fig (1): Effect of irrigation regimes and potassium levels on CGR (g/plant/week) (90-120 DAS) and (120-150 DAS) in combined data

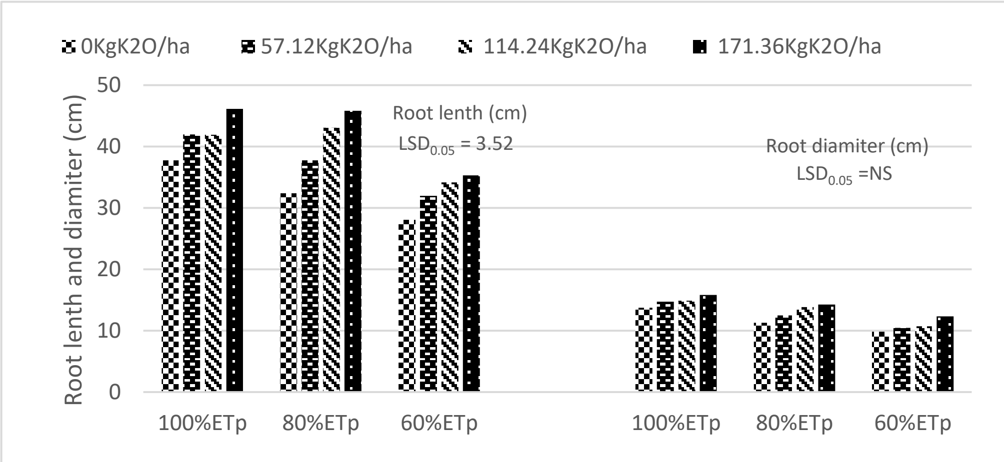

Fig (2): Effect of irrigation regimes and potassium levels on Root length and Root diameter in combined data

Root and Leaves Fresh Weight (kg/plant):

Data in table (5) and (Fig 3) showed that, root and leaves fresh weight (Kg/plant) decreased with increasing soil water moisture stress (I_2, I_3) in both seasons and combining analysis. Foyer and Noctor (2000) stated that drought stress inhibited photosynthetic activity in tissues due to the in balance between light capture and its utilization.

Table (5): Effect of irrigation regimes and potassium levels on Root and Leaves fresh weight (Kg/plant) and Root and Leaves dry weight (g/plant) in 2013/14 and 2014/15 seasons.

Treatment		Root fresh weight (Kg/plant)		Leaves fresh weight (Kg/plant)		Root dry weigh (g/plant)		weight Leaves dry (g/plant)	
Irrigation regimes	Potassium levels Kg/ha	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
I_1	0	1.340	1.346	0.479	0.470	157.41	159.94	64.21	62.90
	57.12	1.398	1.434	0.486	0.490	190.60	195.80	66.02	66.40
	114.24	1.630	1.615	0.491	0.495	290.67	286.41	68.60	71.18
	171.36	1.696	1.742	0.510	0.512	304.2	315.22	72.15	74.90
	Mean	1.516	1.534	0.492	0.492	235.72	239.34	67.74	68.83
I_2	0	1.243	1.342	0.419	0.423	151.32	154.22	61.33	60.88
	57.12	1.309	1.340	0.440	0.456	183.40	189.14	63.72	66.40
	114.24	1.524	1.566	0.446	0.469	269.22	271.68	64.90	69.20
	171.36	1.526	1.602	0..492	0.494	281.67	298.40	71.81	70.33
	Mean	1.401	1.465	0.449	0.461	221.40	228.36	65.44	66.70
I_3	0	1.130	1.154	0.416	0.383	148.67	144.32	58.20	57.66
	57.12	1.286	1.356	0.429	0.417	170.44	222.6	60.18	64.20
	114.24	1.373	1.447	0.431	0.453	250.11	262.41	63.15	67.14
	171.36	1.476	1.525	0.462	0.472	266.14	276.11	66.18	68.20
	Mean	1.316	1.370	0.435	0.431	208.84	241.36	61.92	64.30
Potassium levels 0 Kg/ha		1..237	1.280	0.438	0.425	182.13	193.16	61.24	60.48
Potassium levels 57.12 Kg/ha		1.331	1.377	0.452	0.454	211.48	219.51	63.30	66.66
Potassium levels 114.24 Kg/ha		1.531	1.543	0.456	0.472	270.00	273.50	65.55	69.17
Potassium levels 171.36 Kg/ha		1.544	1.623	0.488	0.493	284.00	296.57	70.04	71.14
$LSD_{(0.05)}$ I		0.081	0.067	0.031	0.022	6.164	6.421	2.021	1.249
$LSD_{(0.05)}$ K		0.069	0.082	0.013	0.014	4.811	5.417	1.179	1.201
$LSD_{(0.05)}$ I *K		0.148	0.137	0.014	0.016	5.963	7.424	2.211	1.759

Irrigation treatment: I_1, I_2, & I_3 = 100, 80, &60% potential evapotranspiration (ETp) class A pan.

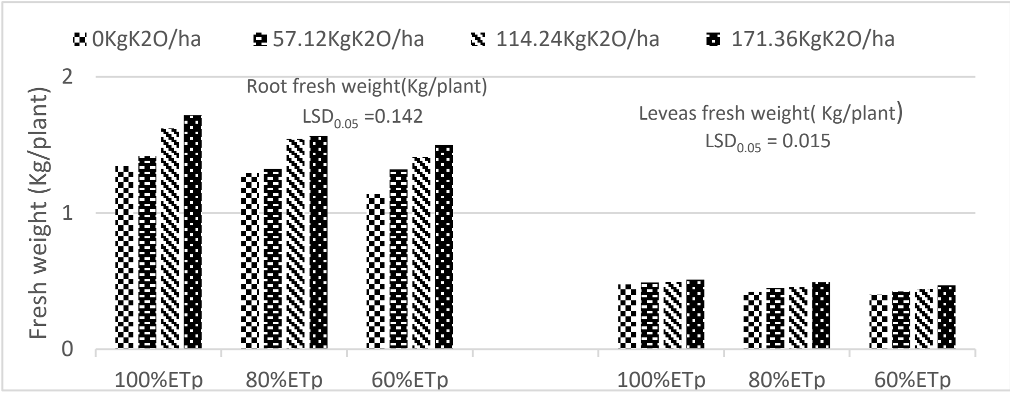

Fig (3): Effect of irrigation regimes and potassium on Root and leaves fresh weight in combined data

As for the effect of potassium fertilization, results indicated that the maximum leaves fresh weight (Kg/plant) achieved when plants received 171.36 KgK_2O/ha in both seasons and combining analysis. While the maximum root fresh weight (Kg/plant) were achieved when plant received 171.36 KgK_2O/ha followed by 114.24 KgK_2O/ha with insignificant differences between such two treatments. In this concern, Tang *et al* (2015) pointed that K is indispensable mineral constituent, intrinsically playing a key role in plant growth and development processes.

From Table (5) and (Fig 3) it was noticed that there was significant interaction between irrigation treatments and potassium fertilization on leaves and root fresh weight (Kg/plant) in both seasons and combining analysis. The maximum values were achieved from plants irrigated with water equal 100% of ET_p and received 171.36Kg K_2O/ha for leaves fresh weight (Kg/plant) in both seasons and combining analysis. While Plants irrigated with water equal 100% of ET_p and received 114.24 and 171.36 KgK_2O/ha gave the highest values for root fresh weight (kg/plant) in both seasons and combining analysis with insignificant difference.

Root and Leaves dry Weight (g/plant):

Results of Table (5) and Fig (4) showed that, decreasing soil water moisture decreased significantly root and leaves dry weight (g/plant) in both seasons and combining analysis. In this concern, the reduction in vegetative biomass caused by drought result in lower plant surface are which reduces the radiation use efficiency and photosynthetic activities [Stockel and kiniry (1990) and Badr *et al* (2004)]. Also, Kramer (1969) conducted that water stress can reduce photosynthesis by reducing leaf area, Closure of stomata and reduction in activity of the dehydrated protoplasmic machinery. These results are in line with Mary Henen (2011) in sunflower plants and Kassab *et al* (2012) in Fodder beet plants.

Concerning to potassium fertilization, data presented in table (5) and Fig (4) clearly show that the application of 171.36 KgK_2O /ha increased significantly leaves and root dry weight (g/plant) in both seasons and combining analysis. These results may be due to that potassium takes part in protein synthesis, carbohydrate metabolism, and enzyme activation, Wang *et al* (2013). In this concern, Egilla *et al* (2001) suggested that, a sufficient supply of K can improve the plant dry weight better than a lower concentration of K can in soil under drought conditions.

Data listed in table (5) and Fig (4) show that there was significant interaction between irrigation regimes and potassium fertilization on leaves and root dry weight (g/plant) in both seasons and combining analysis. The maximum values were obtained from plants watered by 100 (ET_p) and received 171.36 KgK_2O /ha, for root dry weight in the two seasons and combining analysis and for leaves dry weight in the second season and combining analysis. While maximum leaves dry weight value in the first season was achieved from plant watered by 100%, 80% from ET_p and received 171.36KgK_2O/ha with insignificant difference.

Yield and yield component:

Root and foliage weight as well as total weight (ton/ha) are presented in Table (6). Results indicated that root yield and total weight of yield (ton/ha) significantly affected by irrigation treatment in both seasons and combining analysis. The maximum values were achieved when plants irrigated with amount of water equal 100% of (ET_p) (55.195 and 67.25 ton/ha) and (59.934 and 73.00 ton/ha) in both seasons respectively followed by irrigation treatment with amount of water equal 80% of (ET_p) with insignificant differences between such two treatments for root weight and total weight in both seasons and combining analysis. While the lowest values were obtained from plants irrigated with amount of water equal 60% of (ET_p) (36.445 and 44.590) and (41.936 and 52.31 ton/ha) in both seasons and combining analysis. On the other hand, foliage weight (ton/ha) did not affected by water stress. In this concern, Human *et al* (1990)and Hall *et al* (1990) pointed out response to water stress conditions decrease photosynthesis and respiration, and as a result overall production of the crop is decreased. The results coincided with those obtained by kassab *et al* (2012) and sakr *et al* (2014) in fodder beet plants

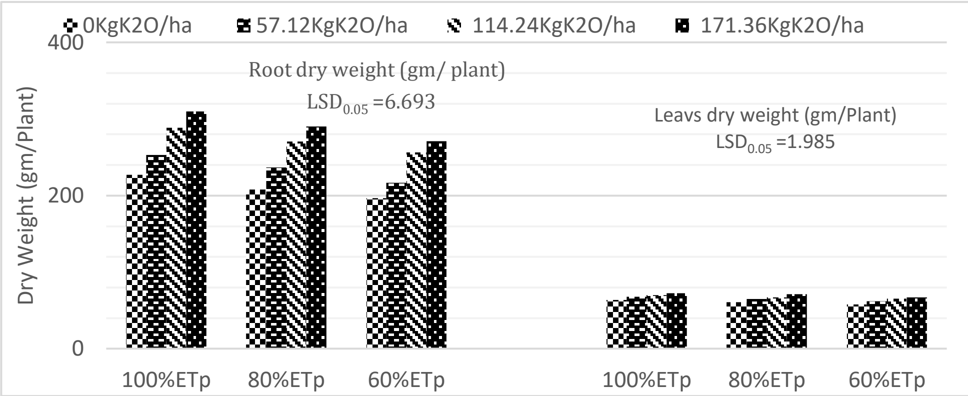

Fig (4): Effect of irrigation regimes and potassium levels on Root and Leaves dry weight in combined data.

Table (6): Effect of irrigation regimes and potassium levels on Root yield ton/ha, Foliage yield ton/ha and total Yield ton/ha in 2013/14 and 2014/15 seasons

Treatment		Root yield ton/ha		Foliage yield ton/ha		yield ton/ha Total	
Irrigation regimes	**Potassium levels Kg/ha**	**2013/14**	**2014/15**	**2013/14**	**2014/15**	**2013/14**	**2014/15**
I_1	0	50.847	56.280	10.323	11.442	61.170	67.772
	57.12	53.078	58.029	11.252	12.301	64.330	70.330
	114.24	55.641	60.151	12.189	13.179	67.830	73.330
	171.36	61.214	65.277	14.456	15.383	75.670	80.660
	Mean	55.195	59.934	12.055	13.076	67.250	73.002
I_2	0	43.665	49.004	9.495	10.656	53.160	59.660
	57.12	50.785	54.061	11.215	11.939	62.000	66.000
	114.24	52.378	56.732	13.782	14.928	66.160	71.660
	171.36	63.028	63.840	11.972	16.160	75.000	80.000
	Mean	52.464	59.909	11.616	13.421	64.080	69.330
I_3	0	32.730	38.321	5.822	7.423	38.552	45.744
	57.12	37.411	39.060	7.820	9.822	45.231	48.882
	114.24	37.110	44.133	9.201	11.141	46.311	55.274
	171.36	38.530	46.192	11.164	13.142	49.694	59.334
	Mean	36.445	41.936	8.507	10.388	44.598	52.324
Potassium levels 0 Kg/ha		42.414	47.868	8.546	9.839	50.960	57.686
Potassium levels 57.12 Kg/ha		47.091	50.383	10.095	11.353	57.186	61.710
Potassium levels 114.24 Kg/ha		48.376	53.671	11.723	13.082	60.100	66.753
Potassium levels 171.36Kg/ha		54.257	58.435	12.529	14.894	66.787	73.33
$LSD_{(0.05)}$ I		5.543	6.764	NS	NS	6.361	6.746
$LSD_{(0.05)}$ K		3.022	3.712	1.582	1.373	4.031	3.145
$LSD_{(0.05)}$ I*K		5.681	4.881	NS	NS	5.292	5.278

Irrigation treatment: I_1, I_2, & I_3 = 100, 80, &60% potential evapotranspiration (ETp) class A pan.

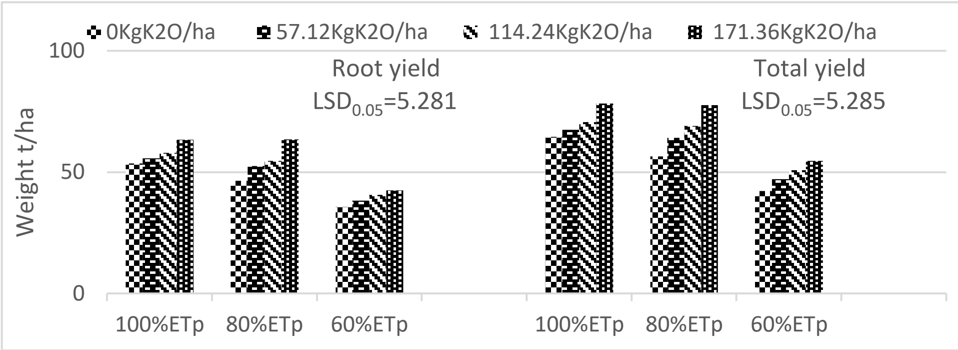

Fig (5) Effect of irrigation regime and potassium levels on root and foliage and total yield (ton/ha) in combined data

As for potassium fertilization, data in Table (6) exhibited that potassium levels had significant effect on yield production of fodder beet plants via. root and foliage weight as well as total weight of yield (ton/ha). Increasing potassium levels up to 171.36 Kg K_2O/ha produced the highest values of these traits in both seasons and combining analysis. The improvements due to increasing potassium fertilization levels may be ascribed to the vital regulatory functions of potassium in photosynthesis process, photosynthesis translocation, improving the osmotic adjustment as well as activation of plant enzymes and antioxidant defense system, (sakr *et al* 2014 and Hasanozzarman *et al* 2018). These results are in line with those stated by Kassab *et al* (2012) and Mary- Nashed *et al* (2019).

There was significant effect due to the interaction between irrigation treatments and potassium levels on root and total weight of yield (ton/ha) in both seasons and combining analysis in table (6) and (Fig 5). The highest values were obtained from plants irrigated with amount of water equal 100% of (ET_p) and received 171.36 Kg K_2O/ha followed by plants irrigated with 80% of ET_p and received 171.36 Kg K_2O/ha with insignificant differences in both seasons and combining data

Total Chlorophyll of leaves:

Data in table (7) showed that total chlorophyll were significantly increased when fodder beet plants watered with wet treatment (amount of water equal 100% from (ETp)), compared to medium or dry treatments, in both seasons and combining analysis. While, dry treatment scored the least value of such trait. That trend, might be due to an important role for pigments formation in leaves. Similar results were obtained by Saad EL-Deen (2006) in sesame plants. The effect of potassium fertilization indicated that adding 171.36 KgK_2O/ha significantly increased total chlorophyll of leaves in both seasons and combining analysis. The significant increase of chlorophyll content as a result of potassium application could be due to function and performance of many plant enzymes especially which involved in leaf pigments formation (Hawksford *et al*, 2012). Similar results were obtained by Mary- Nashed *et al* (2019).

There was no significant effect between water stress and potassium fertilization on total chlorophyll of leaves in both season and combining analysis

Yield Quality:

Forage quality i.e.; potassium (K %), total soluble solids (TSS %), crude protein (CP %), digestible crude protein (DCP %), crude fiber (CF %) and total digestible nutrients (TDN %) significantly affected by water stress in both seasons and combining analysis. (Tables 7 and 8) and (Fig 6).Increasing soil moisture stress up to 60%of ET_p significantly decreased%, CP%, CF% and DCP% in the both seasons and combining data. While, TDN% and TSS% were increased by increasing soil moisture stress in both seasons and combining data. This effect of water stress may be due to the reduction in activities vegetative biomass, photosynthetic activities and dry matter accumulation which lead to the decrease of crud protein and fiber. Similar results were obtained by Sakr *et al* (2014).

With regard to potassium levels, data indicated that there was significant effect on (K %), (CP %), (DCP %), (CF %) and (TDN %) due to potassium fertilization level in both seasons and combining analysis except (TSS %). The highest percentage of CP% in the both seasons and combining data and CF% in the first seasons and combining data were achieved by adding114.24 and 171.36 KgK_2O/ha with insignificant difference. While adding 171.36 KgK_2O/ha gave the maximum K% and DCP% in the both seasons and combining analysis and CF% in the second season. On the other hand, the maximum TDN% were obtained from the treatment 0 KgK_2O/ha in the both seasons and combining analysis. These results might due to the vital role of potassium in improving photosynthetic activity, enhancing N absorption, N metabolism, and protein synthesis. (Wang *et al*, 2013). In addition potassium fertilizers as a soil dressing improve physical, chemical and biological conditions in soil, which increase the metabolic activity of K these by improving plant growth, (Tejada *et al*, 2006).

Table (7): Effect of irrigation regimes and potassium levels on TSS%, K% and Chlorophyll in 2013/14 and 2014/15 seasons

Treatment		TSS%		K%		Chlorophyll mg/m^2	
Irrigation regimes	Potassium levels Kg/ha	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
I_1	0	9.24	8.62	0.411	0.458	621.26	640.8
	57.12	10.11	10.33	0.436	0.490	707.2	721.90
	114.24	12.03	12.34	0.495	0.509	904.5	930.1
	171.36	13.23	13.59	0.524	0.566	1156.4	1201.5
	Mean	10.65	11.22	0.467	0.506	847.34	873.57
I_2	0	10.48	10.66	0.341	0.383	611.9	629.8
	57.12	11.44	12.30	0.426	0.456	690.4	701.4
	114.24	12.79	12.88	0.453	0.480	882.6	904.3
	171.36	13.05	14.11	0.510	0.560	1138.2	1178.2
	Mean	11.80	12.48	0.433	0.474	830.77	853.42
I_3	0	11.21	11.14	0.306	0.333	601.3	614.8
	57.12	12.29	12.67	0.327	0.358	681.7	698.2
	114.24	13.26	14.35	0.409	0.511	869.9	884.1
	171.36	13.71	14.83	0.433	0.531	1118.3	1149.6
	Mean	12.64	13.24	0.368	0.433	817.80	836.67
Potassium levels 0 Kg/ha		9.64	10.14	0.352	0.391	611.48	628.46
Potassium levels 57.12 Kg/ha		10.94	11.76	0.396	0.434	693.10	707.16
Potassium levels 114.24 Kg/ha		12.69	13.19	0.452	0.500	885.66	906.16
Potassium levels 171.36 Kg/ha		13.33	14.17	0.489	0.552	1137.63	1176.43
$LSD_{(0.05)}$ I		1.43	1.52	0.038	0.023	10.016	11.701
$LSD_{(0.05)}$ K		NS	NS	0.031	0.024	7.544	8.128
$LSD_{(0.05)}$ I *K		NS	NS	NS	NS	NS	NS

Irrigation regimes I_1, I_2, & I_3 = 100, 80, &60% potential evapotranspiration (ETp) class A pan.

Table (8): Effect of irrigation regimes and potassium levels on Crud protein%, Crud fiber%, DCP% and TDN% in 2013/14 and 2014/15 seasons.

Treatment		Crud protein%		Crud fiber%		DCP%		TDN%	
Irrigation regimes	Potassium levels Kg/ha	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
I_1	0	6.35	6.83	8.23	7.77	2.41	2.86	85.13	85.65
	57.12	7.22	8.11	8.64	8.59	3.22	3.70	85.02	85.32
	114.24	8.81	8.69	9.01	8.79	4.70	4.59	85.17	85.32
	171.36	9.23	10.23	9.12	9.32	5.09	6.02	85.19	85.30
	Mean	7.90	8.46	8.75	8.61	5.04	4.29	85.12	85.40
I_2	0	5.62	6.13	7.92	7.41	1.74	2.21	85.17	85.75
	57.12	6.29	6.91	8.04	7.65	2.36	2.93	84.77	85.78
	114.24	6.37	7.24	8.62	8.21	2.43	3.24	85.28	85.38
	171.36	7.71	7.66	8.55	8.63	3.68	3.63	85.23	85.15
	Mean	6.49	6.98	8.28	7.97	2.55	3.00	85.11	85.52
I_3	0	5.51	5.49	6.44	5.43	1.63	1.62	86.41	87.28
	57.12	5.31	5.62	7.22	5.75	1.45	1.74	85.45	87.03
	114.24	6.14	5.78	7.48	6.81	2.22	1.88	85.93	86.17
	171.36	6.01	6.35	7.50	6.88	2.10	2.41	85.65	86.28
	Mean	5.74	5.81	7.16	6.21	1.85	1.91	85.86	86.69
Potassium levels 0 Kg/ha		5.82	6.15	7.35	6.87	1.92	2.23	85.57	86.22
Potassium levels 57.12Kg/ha		6.27	6.88	7.90	7.33	2.34	2.79	85.08	86.04
Potassium levels 114.24 Kg/ha		7.10	7.23	8.37	7.93	3.11	3.23	85.46	85.62
Potassium levels 171.36 Kg/ha		7.65	8.08	8.39	8.27	3.62	4.02	85.35	85.57
$LSD_{(0.05)}$ I		1.12	1.34	0.54	0.49	1.03	1.10	0.07	0.06
$LSD_{(0.05)}$ K		0.64	1.04	0.27	0.18	0.44	0.58	0.05	0.05
$LSD_{(0.05)}$ I*K		0.44	0.89	0.24	0.13	0.43	0.48	0.04	0.03

Irrigation regimes I_1, I_2, & I_3 = 100, 80, & 60% potential evapotranspiration (ETp) class A pan.

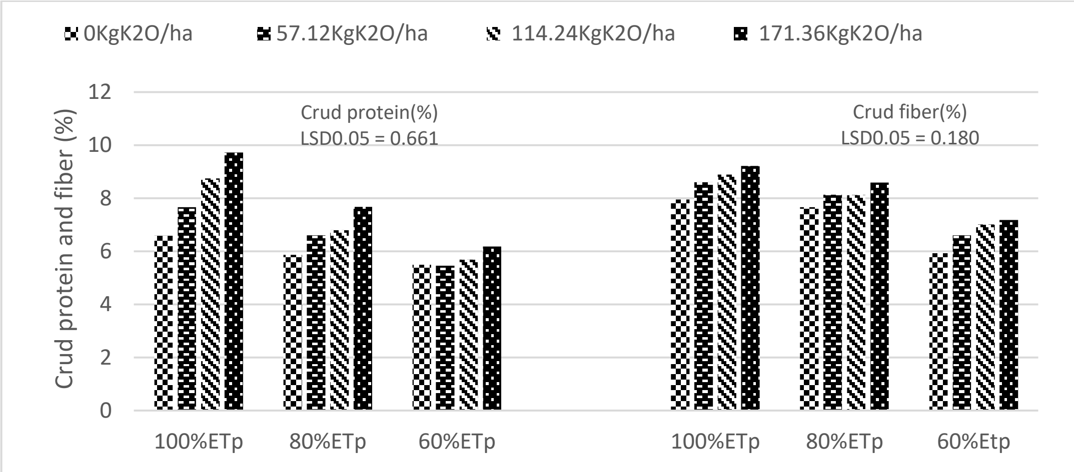

Fig (6) Effect of irrigation regimes and potassium levels on Crud protein%, Crud fiber% in combined data.

Concerning the effect of the interaction between irrigation treatments and potassium fertilization levels, there was significant effect on CP%, CF%, DCP% and TDN% in both seasons, Table (8) combining analysis (Fig 6). The highest percentage of CP%, CF% and DCP% in the first season were achieved from the wet treatment (100% from ET_p) in combination with 114.24 and 171.36KgK_2O/ha with insignificant difference. While the highest CP%, CF% as well as DCP% in the second season and combining data were obtained from the wet treatment in combination with 171.36KgK_2O/ha as for TDN%, the highest percentage were obtained from dry treatment (60% for ET_p) without potassium fertilization (0KgK_2O/ha).

Relative water content (RWC %):

RWC was proposed as good indicator of plant water status (Sinclair and Ludlow, 1985), because RWC through its relation to cell volume, may be more closely reflects the balance between water supply to the leaf and transpiration rate.

Table (9) showed that, RWC significantly affected by the two factors under study. Regarding the effect of water stress on RWC, results indicated that increasing water stress from 100% ETp to 60%ETp significantly decreased RWC at 100 DAS in both seasons and combining analysis. Such finding show the water status in plant cells which affected by water stress conditions. In this respect, (Abdo, Fatma and Anton2009) stated that increasing water stress from 20-50% up to 65-70% significantly decreased RWC at 70 and 84 DAS in sesame plant.

Concerning the effect of potassium fertilization, RWC significantly increased when fodder beet plants received 171.36 KgK_2O/ha compared with other potassium treatments in both seasons and combining analysis. This might be due to that, K controls the evapotranspiration (ET_p) of water through pores under a water deficit in the soil environment, and it protect the plant from water stress Thomas and Thomas (2009). In addition to this effect, the osmotic gradient produced due to the accumulation of K in the root helps to draw water into the root cells Hasanuzzaman *et al* (2018). Similar results were obtained by (Abdo Fatma and Anton 2009) in sesame plant.

The interaction between soil moisture stress and potassium fertilization on RWC of levels was significant. The highest values were scored from plants irrigated by 100% from ET_p and received 171.36 Kg K_2O/ha in both seasons, table (9) and combining analysis (Fig7).

Water utilization efficiency (WU_tE):

The effect of drip irrigation and potassium treatments on water utilization efficiency as kg of fodder beet (root + foliage) yield per m^3 of applied water during the two growing seasons was presented in Table (9). The results showed that WU_tE values were 12.67, 15.10 and 14.12 Kg (root + foliage)/ m^3 applied water in the first season and it were 13.24m 15.71 and 14.82 Kg (root + foliage)/ m^3 applied water in the second season for irrigation treatments I_1, I_2 and I_3 respectively. It could be concluded that medium soil moisture level seemed to be more efficient in consuming water compared with eighteen low water deficit (wet treatment) or severe soil moisture stress (dry treatment) in second season and combining analysis . In other words, from the stand point of water conservation, medium treatment seemed to be more economic for saving water and gained a suitable yield. Similar results on soybean was obtained by Amina (2017).

The values of WU_tE increased with increasing the rate of potassium fertilization under irrigation treatments in the two growing seasons. In this connection, Pendleton (1965) suggested that fertilization practices which provide adequate nutrition for crop plants play a major role in the efficient use and conservation of water resources. The previous results are in line with those obtained by Welch and Flannery (1985) who concluded that water use efficiency of corn plants was increased by raising potassium supply.

The interaction between soil moisture stress and potassium fertilization in Table (9) and Fig (8) show that the maximum value of WU_tE was scored from plants irrigated at 80% from ET_p in combination with adding 171.36KgK_2O/ha in the both seasons and combining analysis.

Table (9): Effect of irrigation regimes and potassium levels on Relative water content (RWC %) and (WUtE) Kg (root + foliage) yield /m³ applied water in 2013/14 and 2014/15 seasons

Treatment		RWC%		(WU_tE) Kg (root+ foliage) /m³ applied water	
Irrigation regimes	Potassium level Kg/ha	2013/14	2014/15	2013/14	2014/15
I_1	0	76.41	81.40	11.529	12.268
	57.12	80.41	84.71	12.130	12.752
	114.24	86.52	90.60	12.785	13.298
	171.36	88.24	93.35	14.265	14.626
	Mean	82.90	87.50	12.676	13.235
I_2	0	72.14	75.25	12.521	13.521
	57.12	74.40	78.83	14.584	14.958
	114.24	80.60	83.20	15.588	16.239
	171.36	82.14	83.41	17.672	18.130
	Mean	77.32	80.16	15.101	15.714
I_3	0	60.71	63.44	12.11	12.96
	57.12	61.35	64.95	14.21	13.85
	114.24	67.95	72.60	14.55	15.66
	171.36	68.70	72.97	15.61	16.81
	Mean	64.67	68.48	14.12	14.82
Potassium levels 0 Kg/ha		69.75	73.35	12.66	13.42
Potassium levels 57.12Kg/ha		72.06	76.16	14.24	14.66
Potassium levels 114.24 Kg/ha		78.35	8.133	14.31	15.56
Potassium levels 171.36 Kg/ha		79.69	83.24	15.85	16.88
$LSD_{(0.05)}$ I		0.587	0.522	0.970	0.881
$LSD_{(0.05)}$ K		0.409	0.484	0.901	0.832
$LSD_{(0.05)}$ I*K		0.742	0.706	1.20	1.21

Irrigation regimes: I_1, I_2, & I_3 = 100, 80, &60% potential evapotranspiration (ETp) class A pan.

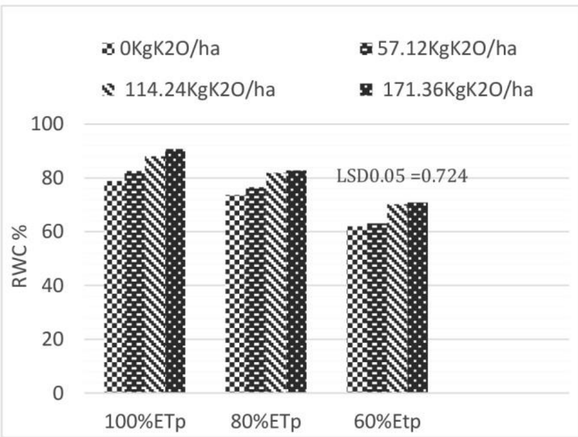

Fig (7) Effect of irrigation regimes and potassium levels on RWC% in combined data

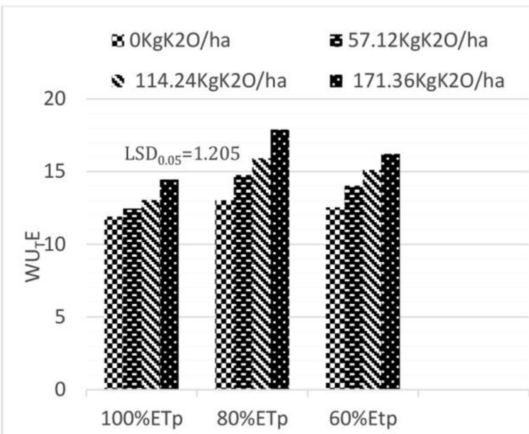

Fig (8) Effect of irrigation regimes and potassium levels on WUtE in combined data

Profitability assessment:

Data in table (10) showed profitability calculations for the input values for different treatments under study, considering the appraisal of all coats and gains of cultivation process. Total input coats, outputs, net income and the investment ratio (I.R) for all tested treatments were presented in tables (11 and 12). The obtained results and their discussion will be handled as follows: Data presented in table (12) show that the highest net income, (10586.25 LE/ha) and I.R value, (1.96) as a mean values of two experimental seasons 2013/14 and 2014/15 were attributed to irrigation treatment (I_2) and potassium fertilization 171.36 kg/ha level under calcareous soil condition. Also, results revealed that the lowest values (3267.98 LE/ha and 1.261) of the same parameters were always related to the absence of K-fertilizer under (I_3) treatment. These results were incorporated with the highest grain yield. Final, from the obtained data it could be concluded that, the investment ratio values were incorporated with the highest net income in the descending order $I_1 > I_2 > I_3$ and the order of $K_4 > K_3 > K_2 > K_1$.

CONCLUSION

In light of the presented data and under calcareous soil conditions it seems evident that drip irrigation regimes and potassium fertilization levels markedly effected on fodder beet yield and it's components and quality. Data, revealed that the higher total fodder beet yield (78.165 Ton/ha, as an average of two seasons) was obtained under I_1 (100% ET_p) treatment and potassium fertilization levels 171.36 Kg K_2O/ha followed by irrigation treatment I_2 (80% ET_p), (77.50 Ton/ha) and the same level of potassium fertilization with insignificant difference between them Also, under the calcareous soil, drip irrigation and experimental conditions, the average amount as a mean values of two growing seasons of applied irrigation water for fodder beet were 5409.93, 4328.01 and 3356.32 m^3/ha for the I_1, I_2 and I_3 irrigation regimes respectively

On the other hand the maximum value of WU_tE (Kg total yield/m^3 applied water) was obtained under I_2 (80% ET_p) and potassium fertilization level 171.36 Kg K_2O/ha.

In view of profitability assessment, results revealed that the highest net income (10586.2 LE/ha) and I.R (1.960) as an average of two growing seasons were obtained under I_2 treatment and 171.36 Kg K_2O/ha level.

Accordingly under calcareous soil conditions and drip irrigation system, it is recommended that about 20% of amounts applied irrigation water could be saved with insignificant decreasing in total fodder beet yield, farm net income and I.R.

Table (10): Input production items and output of the experimental work for fodder bet into the two growing winter seasons of 2013/2014 and 2014/2015

Items	Treatments	Treatments unit	Unit price (L.E) 2013/14	Unit price (L.E)2014/15
Inputs				
Mineral fertilizers				
N	142.8	Kg N/ha	9.55	10.75
P2O5	71.4	Kg P2O5/ha	5.80	5.80
K2O		Kg K2O/ha		
K1	Zero			
K2	57.12		10.42	11.70
K3	114.24		10.42	11.70
K4	171.36		10.42	11.70
Seeds	9.5	Kg /ha.	100	120
Land preparation*		Per/ha.	480	530
Labour**		Per/ha.	1290	1420
Other costs***		Per/ha.	4200	4700
Outputs Fodder beet yield		Ton/ha.	260	280

* Rent of agricultural machines

** Cultivation, irrigation, fertilization, Thinning,.. etc.

*** Land rent, transportation of seeds, fertilizers,.. etc. Irrigation and drainage systems conservation, . etc.

Table (11): Experimental total inputs (L.E/ ha) during the two growing seasons 2013/14 and 2014/15.

Treatments		Mineral Fertilizers (L.E /ha)			Seed (L.E/ ha)	Land preparation (L.E/ ha)	Labour (L.E/ ha)	Other coats (L.E/ ha)	Total inputs (L.E/ ha)
irrigation regimes	Potassium level Kg/ha	N	P_2O_5	K_2O					
		2013/14							
I_1	0	1363.74	414.12	-	950	480	1290	4200	8697.86
	57.12	1363.74	414.12	595.19	950	480	1290	4200	9293.05
	114.24	1363.74	414.12	1190.38	950	480	1290	4200	9888.24
	171.36	1363.74	414.12	1785.57	950	480	1290	4200	10483.43
I_2	0	1363.74	414.12	-	950	480	1290	4100	8597.86
	57.12	1363.74	414.12	595.19	950	480	1290	4100	9193.05
	114.24	1363.74	414.12	1190.38	950	480	1290	4100	9788.24
	171.36	1363.74	414.12	1785.57	950	480	1290	4100	10383.43
I_3	0	1363.74	414.12	-	950	480	1290	4000	8497.86
	57.12	1363.74	414.12	595.19	950	480	1290	4000	9093.05
	114.24	1363.74	414.12	1190.38	950	480	1290	4000	9688.24
	171.36	1363.74	414.12	1785.57	950	480	1290	4000	10283.43
	2014/15								
I_1	0	1535.1	414.12	-	1140	530	1420	4700	9739.22
	57.12	1535.1	414.12	668.30	1140	530	1420	4700	10407.57
	114.24	1535.1	414.12	1336.61	1140	530	1420	4700	11075.83
	171.36	1535.1	414.12	2004.91	1140	530	1420	4700	11744.13
I_2	0	1535.1	414.12	-	1140	530	1420	4600	9639.22
	57.12	1535.1	414.12	668.30	1140	530	1420	4600	10307.57
	114.24	1535.1	414.12	1336.61	1140	530	1420	4600	10975.83
	171.36	1535.1	414.12	2004.91	1140	530	1420	4600	11644.13
I_3	0	1535.1	414.12	-	1140	530	1420	4500	9539.22
	57.12	1535.1	414.12	668.30	1140	530	1420	4500	10207.57
	114.24	1535.1	414.12	1336.61	1140	530	1420	4500	10875.83
	171.36	1535.1	414.12	2004.91	1140	530	1420	4500	11544.13

Table (12): Profitability assessment of the tested variables for fodder beet crop under the present investigation in the two winter seasons of 2013/14 and 2014/15

Treatments		Yield Ton/ha			Inputs L.E ha^{-1}			Outputs L.E ha^{-1}			Net income L.E ha^{-1}			IR		
irrigation regimes	Potassium. Levels kg/ha	2013/14	2014/15	Mean	2013/14	2014/15	Mean	2013/14	2014/15	Mean	2013/14	2014/15	Mean	2013/14	2014/15	Mean
I_1	0	61.170	67.772	64.471	8697.86	9739.22	9218.54	15904.2	18944.8	17424.5	7206.3	9205.6	8205.9	1.83	1.95	1.89
	57.12	64.330	70.330	67.330	9293.05	10407.52	9850.28	16725.8	19692.4	13209.1	7432.3	9284.9	8358.6	1.80	1.89	1.845
	114.24	67.830	73.330	70.580	9888.24	11075.83	10482.0	17635.8	20532.4	19084.1	7747.6	9456.6	8602.1	1.78	1.85	1.815
	171.36	75.670	80.660	78.165	10483.4	11744.13	1113.78	19674.2	22584.8	221129.5	9190.8	10840.7	10015.7	1.88	1.92	1.900
I_2	0	53.160	59.660	56.410	8597.86	9639.22	9118.54	13821.6	16704.8	15263.2	5223.7	7065.6	6144.6	1.61	1.73	1.670
	57.12	62.000	66.000	64.000	9193.05	10307.57	8750.31	16120.0	18480.0	17300.0	6926.9	8172.4	7549.6	1.75	1.79	1.770
	114.24	66.160	71.660	68.910	9788.24	10975.83	10382.0	17201.6	20064.8	18633.2	7413.4	9088.9	8251.1	1.76	1.83	1.795
	171.36	75.000	80.000	77.500	10383.4	11644.14	11013.7	20800.0	22400.0	21600	10416.6	10755.9	10586.2	2.00	1.92	1.960
I_3	0	38.552	45.744	42.149	8497.86	9539.22	9018.54	10023.0	12807.2	11415.1	1525.12	3267.98	2396.55	1.179	1.343	1.261
	57.12	45.231	48.882	47.055	9093.05	10207.57	9650.31	11759.8	13686.4	12723.1	2666.75	3478.83	3072.79	1.293	1.341	1.317
	114.24	46.311	55.274	50.790	9688.24	10875.83	10282.0	13514.8	15475.6	14495.2	3826.56	4599.77	4213.17	1.395	1.423	1.409
	171.36	49.694	59.334	54.512	10283.4	11544.13	10913.7	14723.8	16612.4	15668.1	4440.37	5068.27	4754.42	1.432	1.439	1.436

IR (Investment ratio) = Output / Input.

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الاستجابة الفسيولوجية و انتاجية بنجر العلف لمعدلات الرى بالتنقيط ومستويات من التسميد البوتاسى تحت ظروف الاراضى الجيرية

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أجريت تجربتان حقليتان فى المزرعة البحثية بمحطة البحوث الزراعية بالنوبارية خلال عامي ٢٠١٣ – ٢٠١٤ ، ٢٠١٤ – ٢٠١٥ وذلك لدراسة تأثير ثلاث مستويات ري وهى (الري بكمية مياه تعادل ١٠٠% من جهد البخر نتح والثانية الري بكمية مياه تعادل ٨٠% من جهد البخر نتح والثالثة الري بكمية مياه تعادل ٦٠% من جهد البخر نتح) وأربع مستويات للتسميد البوتاسي بمعدل صفر ، ٥٧,١٢ ، ١١٤,٢٤ ، ١٧١,٣٦ وحدة أكسيد بوتاسيوم كجم/ هكتار على الاستجابه الفسيولوجيه و محصول بنجر العلف وبعض مكونات المحصول وكذلك على كفاءة استعمال وحدة المياه فى الأراضي الجيرية تحت ظروف الري بالتنقيط . وقد تم حساب صافى الدخل المزرعى والعائد الاستثمارى لوحدة الجنيه تحت ظروف ومعاملات التجربه.

ويمكن تلخيص النتائج المتحصل عليها من الدراسة كما يلي :

زيادة معدل الرى ادى الى زيادة معنوية فى معدل نمو المحصول عند فترتى ٩٠–١٢٠ , ١٢٠–١٥٠ يوم من الزراعة, الوزن الخضرى للاوراق و الجذور بالكجم/نبات, الوزن الجاف للاوراق و الجذور بالجم/نبات, طول و قطر الجذر و كذلك محصول الجذور و المحصول الكلى طن/هكتار. ومحتوى الاوراق من الكلوروفيل و أدى الرى بالمعاملة الجافة الى نقص معنوى فى نسبة البوتاسيوم, البروتين الخام و المهضوم و الالياف الخام بينما زادت نسبة المواد الصلبة الكلية و مجموع المواد الغذائية المهضومة تم الحصول على اعلى نسبة للمحتوى المائى للاوراق من معاملة الرى الرطبة, بينما ادت المعاملة ٨٠% من البخر نتح الى الحصول على اعلى قيمة لمعدل استخدام المياه.

التسميد بمعدل 171.37 KgK_2O/ha ادت الى زيادة معنوية فى معدل النمو عند فترتى ٩٠–١٢٠ ,١٢٠–١٥٠ يوم من الزراعة, الوزن الخضرى للاوراق كجم/نبات, الوزن الجاف للجذور و الاوراق جم/نبات, طول و قطر الجذر و محصول الاوراق و الجذور و كذلك المحصول الكلى بالطن/هكتار و محتوى الاوراق من الكلوروفيل و ايضا البروتين المهضوم و نسبة البوتاسيوم. عند التسميد بمعدل 114.24, 171.36 KgK_2O/ha ادى الى زيادة معنوية فى الوزن الخضرى للجذور بالكجم/نبات و البروتين الخام و الالياف الخام بدون فرق معنوى بينهم. بينما حدث انخفاض معنوى فى نسبة مجموع المواد الغذائية المهضومة بزيادة التسميد البوتاسى. وتم الحصول على اعلى قيم للمحتوى المائى للاوراق و كذلك كفاءة استخدام المياه من التسميد بمعدل 171.36 KgK_2O/ha.

كان تاثير التفاعل بين معدلات الرى و التسميد البوتاسى معنويا لكل الصفات تحت الدراسة ماعدا معدل النمو عند ٩٠–١٢٠ يوم من الزراعة, قطر الجذور, محصول العلف طن/فدان و محتوى الاوراق من الكلوروفيل و نسبة البوتاسيوم و كذلك المواد الصلبة الكلية. تم الحصول على اعلى قيم من معدل النمو عند ١٢٠–١٥٠ , للوزن الخضرى للاوراق كجم/نبات, الوزن الجاف للاوراق و الجذور جم/نبات, البروتين الخام و كذلك الالياف الخام والروتين المهضوم و المحتوى المائى للاوراق من معالمة الرى ١٠٠% من البخر نتح و اضافة 171.36 KgK_2O. بينما الرى ب ١٠٠% و ٨٠% بخر نتح و التسميد بمعدل 171.36 KgK_2O اعطى اعلى قيم بالنسبة لطول الجذر و محصول الجذور و المحصول الكلى بالطن/هكتار و كذلك كفاءة استخدام المياه بدون فرق معنوي بينهم. الرى ب ١٠٠% من البخر نتح و التسميد بمعدل 171.36,114.24 KgK_2O/ha اعطى اعلى قيم للوزن

الخضرى للجذور كجم/نبات بدون فرق معنوى بينهم. بينما تم الحصول على اعلى قيم لل مجموع المواد الغذائية المهضومة من معاملة الرى عند ٦٠% من البخر نتح مع عدم التسميد البوتاسى.

بلغ متوسط كميات مياه الرى المضافة للموسمين لمحصول بنجر العلف ٥٤٠٩,٩٣، ٤٣٢٨,٠١ و ٣٣٥٦,٣٢ متر مكعب للهكتار لمعاملات الري ١٠٠%،٨٠%، ٦٠% من جهد البخر نتح على التوالي فى الأراضي الجيرية تحت نظام الري بالتنقيط

وتشير النتائج الى ان كفاءة استخدام وحدة المياه المضافة تزيد بزيادة كمية المياه المضافة حتى ٨٠% من البخر نتح وبلغت أقصي قيمة ١٧,٦٧، ١٨,١٣ كيلو جرام (اوراق + جذور) محصول بنجر العلف / متر مكعب من المياه فى السنة الاولي والثانية على التوالي عند الري بكمية مياه تعادل ٨٠ % جهد بخر نتح وتحت معدل تسميد بوتاسى ١٧١,٣٦ كيلو جرام /هكتار. وبصفه عامه زيادة التسميد البوتاسي أدى الى زيادة كفاءة استخدام مياه الري تحت جميع معاملات الرى .

و قد اظهرت الدراسة الاقتصادية ان اعلى صافى دخل مزرعى (١٠٥٨٦,٢ جنيها/هكتار) و اعلى عائد استثمارى (١,٩٦٠) كمتوسط للموسمين قد تحقق تحت مستوى رى يكافئ ٨٠% من جهد البخر نتح مع معدل اضافة ١٧١,٣٦ كجم/هكتار من السماد البوتاسى.

تشير النتائج السابقة بأنه تحت ظروف الاراضى الجيرية والرى بالتنقيط وتحت ظروف التجربة الى أمكانية توفير ٢٠% من كميه المياه المضافة تحت مستوي التسميد البوتاسى ١٧١,٣٢ كيلو جرام/هكتار دون ان يحدث نقص معنوى فى محصول بنجر العلف.