Thi-Qar J. Agric. Res., 7 (1) 2018

Evaluation Of Performance Of Some Varieties Of Sorghum Bicolor L. Under Different Levels Of Nitrogen Fertilization

Salih Hadi Farhood Al-salim [(I)] & Maysoun Mohamed Saleh [(II)] & Saad Adnan Manhal Albadry [(III)]

[(I)] **Ministry of Agriculture, Agriculture Directorate of Thi-Qar , Iraq. salihalsalim@gmail.com**
[(II)] **General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria. mzainsamasaleh@gmail.com**
[(III)] **University of Thi-Qar, college of agriculture and Marshes, Iraq. Agriculture_ss@yahoo.com**

Corresponding author's e –mail Agriculture_ss@yahoo.com

A field experiment carried out in Iraq with two locations. The first location was in Al- Eslah district southeast Nassiryah city, while the second location was qalat sekar district north Nassiryah in 2016. The factors that used in an experiment were four cultivars of sorghum (Kafer, Al-khayer, Rabeh, and Enqadh) with three levels of Nitrogen fertilizers (80,100 and 120) kg/ha^{-1}. The layout of the factorial experiment was R.C.B.D. with three replications to evaluation the performance of cultivars according to Nitrogen levels. Studied traits were (plant height, stem diameter, leaf area index, wet and dry forage weight, seed number and seed yield). The results of analysis variance showed significant differences among cultivars, fertilizer levels and locations in all traits. Also the Enqadh and Rabeh cultivars overcome significantly in seed yield (5.717, 5.543) ton/ha^{-1} respectively. The fertilizer level (100) kg/ha^{-1} was the best than other levels. The significant difference showed that between locations in dry forage weight and Leaf area index. Also, the interaction between cultivars and fertilizer levels was significant in dry forage weight.

Keywords: Sorghum bicolor, Wet forage weight, Dry forage weight, stem diameter, LAI.

INTRODUCTION

Sorghum crop ranking the fifth order among cereals crops in the world after wheat, rice, maize and barley (Kole,2003; Agrama and Tuinstra, 2011) as of economic importance and cultivated area (FAO,2009). This crop has an important role in developing countries (Buah and Mwinkaara, 2009). Sorghum crop belongs to poacea family and represent an essential source of forage and used in energy and other artificial industries especially candle industry (Afzal et al., 2012). Nitrogen fertilizer considers an essential element to enhance sufficient food as increasing production of crops for more than fifty years ago until now in which the increasing in seed yield that is resulted from nitrogen fertilization that inquires of insurance life more than half people (Erisman et al., 2008).

Nitrogen element contributes to accelerating growth and increasing the yield, especially in arid and semi-arid regions in the world (Tookallo, 2014). Zandan et al.,(2014) conducted an experiment in Iran to evaluation seed yield and yield components with different levels of N (40, 80 and 120) kg/ha^{-1} and plant densities, in which the results showed significant effects in seed number and seed yield traits, so both of them increased with increasing N fertilizer levels.

Moghimi and Emam, (2015) carried out an experiment to study the effect of three levels of N fertilizer (69, 138 and 205) kg/ha^{-1} on two cultivars for two years

with three replications in which the results revealed that increasing of N fertilizer level resulted in an increasing in plant height, Leaf area index and dry forage weight also significant differences in response to N levels.

Results of Ikanovi et al.,(2010) about evaluation of three cultivars of sorghum and their response for different levels of N fertilizer in Serbia during 2007- 2008 years showed that plant height and forage weight traits gave a significant differences among cultivars and N fertilizer in which the better level of N was (105) kg/ha^{-1}. Also, a similar experiment conducted in the investigation of a better level of N fertilizer on sorghum crop amongst some levels (0, 50, 75 and 100) kg/ha^{-1}which the results exposed that the level (100) kg/ha^{-1} was the best in forage quality (Afzal et al., 2012).

The research aims to the evaluation of cultivars performance with fertilizers levels in two locations and limiting optimum fertilizer level and cultivars to using it in genetic improvement programs.

MATERIALS AND METHODS

A factorial field experiment carried out in R.C.B.D. layout with three replications, the factors were four sorghum cultivars (Al-Khayer, Enqadh, Kafer, and Rabeh) which cultivated by hand in 2016 in lines (6) m long, between them (70) cm and among plants were (20) cm as an irrigated cultivation. The distance (1) m among plots was done for isolation cultivars. The experiment composed of two locations, the first was in Al-Eslah district, while the second was in Qalet Seker district. All agricultural activities such as Irrigation and pesticide control conducted according to Agriculture Ministry guides, the following traits that studied were:

1- plant height (cm): the height measured during the flowering stage from the base of the plant to the top of the head (IBPGR&ICRISAT, 1993).
2- Stem diameter (cm): measured during maturity stage at height (5) cm above ground.
3- Leaf area Index: measured from equation LAI= LA/P. in which (LA) is leaf area of the plant and (P) is the ground area under the plant. Leaf area of plant measured from equation LA= [maximum leaf length× maximum leaf width × 0.75].
4- Wet forage weight (ton/ ha^{-1}): the wet forage weight of shoot system was taken after harvest and converted to (ton/ ha^{-1}).
5- dry forage weight (ton/ ha^{-1}): the dry forage weight of shoot system was taken after drying of wet forage in Oven at (70˚).
6- Seed number in the ear.
7- Seed yield (ton/ ha^{-1}): measured by means of seed yield was taken in plot and converted to (ton/ ha^{-1})

The results analyzed using Genstat with Least Significant Difference (L.S.D.) at P-value (0.05). coefficient variance (C.V.%) calculated among cultivars as the main factor, fertilizer levels as a secondary factor and between locations as the third factor. All interactions were taken into consideration.

Results and discussion

The results of analysis of variance showed significant differences among cultivars and fertilizer levels for all studied traits, also between locations there was just significant differences in dry forage weight and leaf area index traits. The fertilizer level (120 $kg.ha^{-1}$) of N has a significant effect on studied traits and the interaction between cultivars and fertilizer was significant in dry forage weight (table 2).

Plant height (cm):

The cultivated cultivars varied in plant height in which Enqadh cultivar characterized by this trait to reach (162.7) cm followed by Rabeh, Al-khayer and Kafer cultivars with means (155.3, 149.5 and 146.2) cm respectively (figure1). Also the mean of plants height for all cultivars between locations increased significantly as increase in Nitrogen level and the level (120 kg.ha^{-1}) of N recorded maximum height reached (170.70) cm followed by (100 kg.ha^{-1}) of N reached (151.9) cm comparing with minimum height (137.68) cm for all cultivars with (80 kg.ha^{-1}) of N level (table 3). Non-significant differences did not show between first and second locations (153.8 and 153.68) cm. This results agree with Hassan, (2005) which showed that the sorghum cultivar effect on all traits specially plant height and with (Bello et al.,2007; El Naim et al.,2010) also with results of (Afzal et al.,2012) which showed that the increasing in Nitrogen Fertilizer caused increasing in plant height as a result that Nitrogen element can contribute to making Energy compounds ATP and membrane walls also accelerate plant growth as increasing in stem nodes and internodes (Eltelib, 2004).

Stem diameter (cm):

The cultivated cultivars varied significantly in stem diameter in which Enqadh cultivar gave higher diameter reached (12.68) cm followed by Rabeh and Al-khayer (11.80 11.78) cm respectively without differences between them, comparing with lower mean (10.86) cm for Kafer cultivar (figure2).

The increasing in Nitrogen fertilizer level resulted in increasing in stem diameter reached (10.68, 11.68 and 12.98) cm of levels (80,100 and 120 kg.ha $^{-1}$) respectively (table 3), while the effect of locations did not record significant differences in this trait (11.69 and 11.87) cm respectively. These results agree with Ikanovic et al.,

(2010) which proved significant differences among genetic cultivars of sorghum and with (Banziger et al., 2002; Subedi and Ma., 2005) which showed that some of the traits such, stem diameter increased with increasing in Nitrogen fertilizer.

Wet and dry forage weight (ton.ha^{-1}):

The cultivars varied in wet and dry forage weight significantly which Enqadh cultivar gave a higher mean of wet weight followed by Rabeh (27.10 and 26.42) ton.ha^{-1} respectively, while Kafer cultivar gave lower mean of wet forage weight (22.71) ton.ha^{-1} followed by Al-Khayer cultivar (23.70) ton.ha^{-1}. Also, dry forage weight which Enqadh cultivar gave higher mean (12.54) ton.ha^{-1} followed by Rabeh cultivar (11.52) ton.ha^{-1} followed by Al-Khayer cultivar (9.68) ton.ha^{-1} comparing with a lower mean of Kafer cultivar reached to (9.04) ton.ha^{-1} (figure 3). Also the data showed increasing in wet and dry forage weight with the increasing of fertilizer level which were (24.163, 24.894 and 25.893) ton.ha^{-1} for wet weight and (9.650, 10.848 and 11.588) ton.ha^{-1} for dry weight to the levels (80, 100, 120) ton.ha^{-1} respectively (table 3). Both locations did not show any significant differences of wet forage weight (24.964, 25.003) ton.ha^{-1} comparing with the significant differences of dry forage weight between locations in which the first gave higher mean (10.842) ton.ha^{-1} while the second location gave lower mean (10.548) ton.ha^{-1}(figure 4). Also the results revealed that the interaction between cultivars and fertilizer levels were significant for dry forage weight which Enqadh cultivar was higher with the level (120 kg.ha^{-1}) reached (14.042) ton.ha^{-1} followed by Enqadh with level (100 kg.ha^{-1}) and Rabeh cultivar with level (120 kg.ha^{-1}) without any significant differences (12.707 and 12.64) ton.ha^{-1} and followed after that by Rabeh cultivar (11.815) ton.ha^{-1} with the level (100 kg.ha^{-1}) comparing with Kafer the lower cultivar for

fertilizer level (80 kg.ha^{-1}) reached (8.533) ton.ha^{-1} (figure 5). This may be because that the higher cultivar in wet and dry forage weight formed higher plant height and bigger stem diameter comparing with others, these results were supported with (Jain and Patel., 2014) and (Borel and Hammer., 2000). The results agree with more research which showed that the increasing in Nitrogen fertilizer increased wet and dry forage weight (Khair and Salih., 2007;Eltelib., 2004; Devi., 2002; Ram and Singh., 2000; Ammaji and Suryanarayana., 2003; Ayub et al., 2002; Rahman et al., 2001; Ivanovic et al., 2010).

Leaf Area Index:

Cultivated cultivars, locations and fertilizer levels varied significantly in this traits in which second location recorded high mean (9.446) for leaf area index comparing with (8.768) for second location (figure 4) while with regard to cultivars, the cultivar Enqadh was higher significantly in leaf area index followed by Rabeh with mean (10.137 and 9.127) respectively in comparison with lower mean in this trait for Kafer cultivar (8.522). Also, Al-khayer cultivar had nonsignificant differences with both cultivars Rabeh and Kafer reached (8.643) (figure 3). The result also revealed increasing in (LAI) with increasing in fertilizer level in which the means (9.689, 9.113 and 8.520) for the levels (120, 100 and 80 kg.ha^{-1}) respectively (table 3). The results agree with Khalili et al., (2007) who were confirmed to be a significant difference among hybrids of sorghum in this trait and with results of Moghimi and Emam., (2015) who showed that increasing in (LAI) with increasing of Nitrogen fertilizer which supported with other researchers (Shamme et al., 2015; Tookallo., 2014).

Seed number (seed.plant^{-1}) :

The result showed that the Enqadh cultivar characterized significantly by higher seed number.plant $^{-1}$(2095) seed.plant $^{-1}$ followed by Rabeh cultivar (1868) seed.plant $^{-1}$with significant differences comparing with other, while there are nonsignificant differences between Al-Khayer and Kafer cultivar which were in lower means in seed number reached (1678 and 1669) seed.plant $^{-1}$ respectively (figure 6). As belong locations, there are nonsignificant differences in this trait (1805, 1851) seed.plant $^{-1}$, while the increasing in Nitrogen level gave increasing reached (1436) seed.plant $^{-1}$ with the level of fertilizer (80 kg.ha^{-1}) which was lower significantly comparing with increasing in seed number that reached (1967 and 2080) seed.plant $^{-1}$ for levels (100 and 120 kg.ha^{-1}) with nonsignificant differences between them (table 3). These results agree with Gajanan et al., (2016) who showed significant differences in seed number and height plant among sorghum cultivars, also the results agree with Zand et al., (2014) who showed that the increasing in fertilizer level resulted in an increasing in seed number and seed yield.

Seed yield (ton.ha^{-1}):

Results showed that Enqadh and Rabeh cultivars overcome in seed yield which the means reached (5.717 and 5.547) ton.ha^{-1}for each other respectively with non-significant differences between them as a result of characterizing in plant height, stem diameter and (LAI) which contributed to gave sufficient quantities of photosynthate that converted to seed, followed then by Al-Khayer cultivar with mean (5.016) ton.ha^{-1} while Kafer cultivar was lower significantly in seed yield reached (4.586) ton.ha^{-1}(figure 7). Non-significant differences do not found between locations in this trait (5.284 and 5.138) ton.ha^{-1} respectively, and in same with other traits there were significant differences in seed yield among fertilizer levels in which the seed yield reached (4.608, 5.245 and 5.780) ton.ha^{-1} when the levels (80,100 and

120 kg.ha $^{-1}$) used respectively (table 3). The results agree with Zand et al.,(2014) about founding significant differences among sorghum cultivars in seed yield, also these results agree with (Khosla et al.,2000; Abd, 2008; OMAF., 2002; Bush and mwinkaara., 2009; Diallo, 2012).

Conclusions :

The cultivated cultivars varied significantly in all studied traits which better cultivars was Enqadh followed by Rabeh then Al-Khayer while the lower cultivar was Kafer, and as regarding with Nitrogen fertilizer there was a significant effect in all traits which was the best level (120 kg.ha $^{-1}$). Also, the locations of research varied significantly just in dry forage weight, LAI and the interaction between cultivars and fertilizer was significantly in dry forage weight.

Suggestions :

Enqadh and Rabeh cultivars must use in genetic improvement programs to improve the seed yield, and we recommend to apply the fertilizer level (100 kg.ha^{-1}) because it gave high forage weight and seed yield. Also, we recommend to expanding in cultivation the cultivars Enqadh and Rabeh in the locations of research because there are no environmental variance between both locations which reflex the stability of seed yield

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Location Characteristics	texture	PH	EC des/m	Soil gradients %			العناصر المعدنية%	
				Sand	**Silts**	**Clay**	N TOT g/kg	K mmole
Al-Eslah	Silty	7.8	7.91	22	59	19	0.61	1.84
Qalet Seqar	Sandy loam	7.3	7.88	31	48	21	0.50	2.02

Table (1) Soil analysis of research locations

Table (2) Analysis Variance ANOVA of Studied traits

Source Variance	Freedom degree	متوسط مربع الانحرافات						
		Plant height	Stem diameter	LAI	Seed No.	Wet forage Weight	Dry forage Weight	Seed Yield
Varities	**3**	**940.78**^{S}	9.959 ^{S}	**9.7122**^{S}	**722470** ^{S}	**80.0769** ^{S}	**47.0259** ^{S}	**4.9020** ^{S}
Fertilizer	**2**	**6584.57**^{S}	**32.069** ^{S}	**8.2023**^{S}	**2842402**^{S}	**18.1096** ^{S}	**22.9599** ^{S}	**8.2515** ^{S}
Locations	**1**	4.50	0.572	**8.2757**^{S}	38133	0.0272	**1.5547** ^{S}	0.3872
Varities *Fertilizer	**6**	71.90	2.082	1.2110	115054	0.8708	**1.8463** ^{S}	0.2726
Varities *locations	**3**	2.34	0.419	0.0308	2060	0.8017	0.5114	0.0658
Locations *Fertilizer	**2**	25.07	0.004	0.0423	2844	0.0505	0.1014	0.0963
Locations *Fertilizer*varities	**6**	2.84	0.188	0.0084	2067	0.1200	0.0964	0.2391
L.S.D Varities		**2.757** ^{S}	**0.885** ^{S}	**0.4995**^{S}	**175.4** ^{S}	**0.3104** ^{S}	**0.2315** ^{S}	**0.3281**^{S}
L.S.D Fertilizer		**2.388** ^{S}	**0.766** ^{S}	**0.4326**^{S}	**151.9** ^{S}	**0.2688** ^{S}	**0.2005** ^{S}	**0.2841**^{S}
L.S.D Locations		1.949	0.626	**0.3532**^{S}	124.0	0.2195	**0.1637** ^{S}	0.2320
L.S.D Varities *Fertilizer		4.775	1.532	0.8651	303.7	0.5376	**0.4009** ^{S}	0.5683
L.S.D Varities *locations		2.388	1.251	0.7064	248.0	0.4390	0.3274	0.4640
L.S.D Locations *Fertilizer		3.376	1.083	0.6118	214.8	0.3802	0.2835	0.4018
L.S.D Locations *Fertilizer*varities		6.753	2.167	1.2235	429.5	0.7603	0.5670	0.8037
C V %		**2.7**	**11.2**	**8.2**	**14.3**	**1.9**	**3.2**	**9.4**

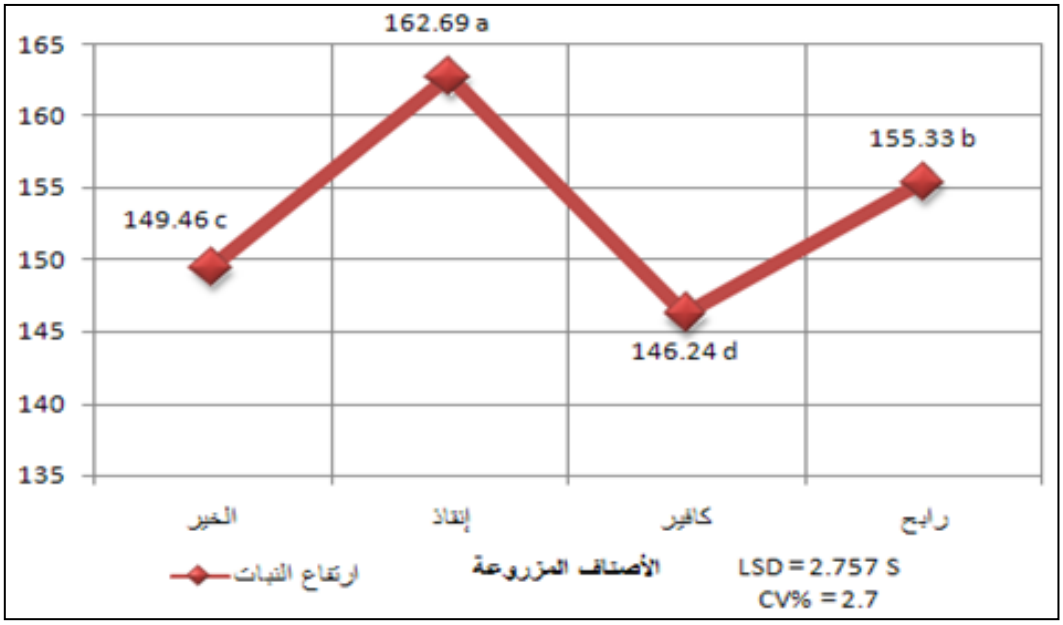

Figure (1) Plant hight mean (cm) of Varities.

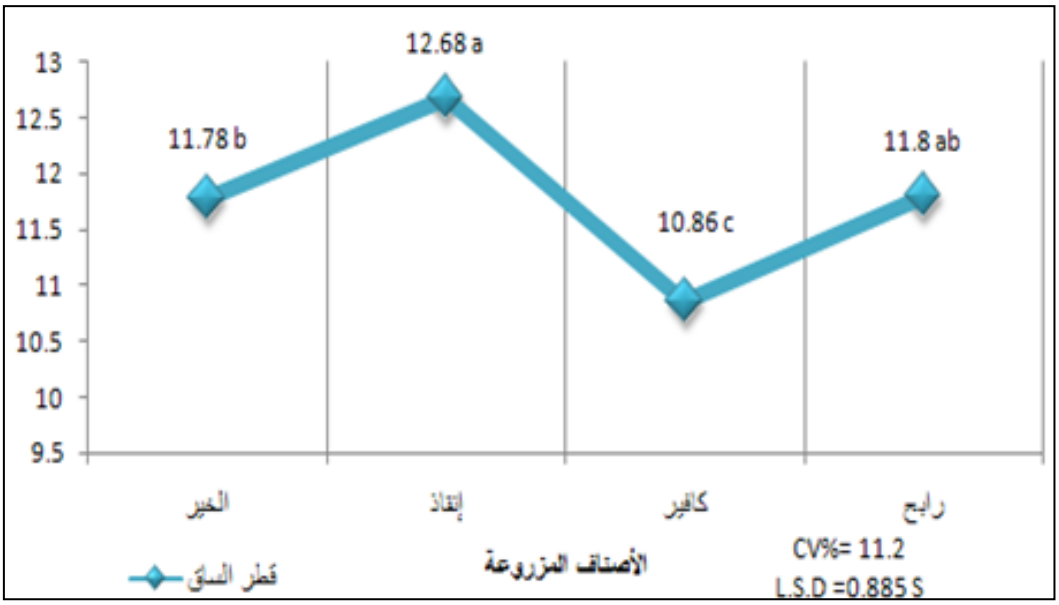

Figure (2) Stem diameter mean (cm) of Varities.

Table (3) Effect of Nitrogen Fertilizer on Mean of varieties traits in locations

Traits	N 80	N 100	N 120	L.S.D	CV%
Plant hight	137.68 c	151.91b	170.70 a	2.388 s	2.7
Stem diameter	10.68c	11.68b	12.98a	0.766 ^{S}	11.2
LAI	8.520c	9.113b	9.689a	0.4326^{S}	8.2
Wet Forage weight	24.163c	24.894b	25.893a	0.2688 ^{S}	14.3
Dry Forage weight	9.650c	10.848b	11.588a	0.2005 ^{S}	1.9
Seed No.	1436b	1967a	2080a	151.9 ^{S}	3.2
Seed Yield	4.608c	5.245b	5.780a	0.2841^{S}	9.4

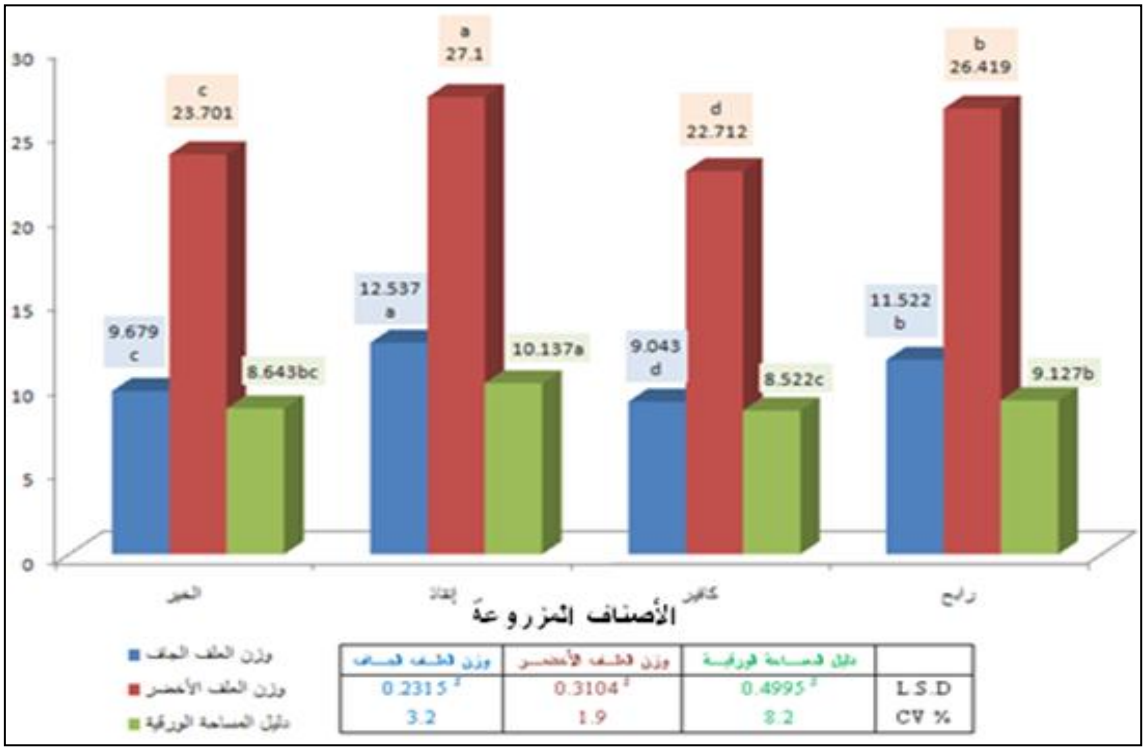

Figure (3) Means of Wet & Dry forage weight and LAI among Varieties

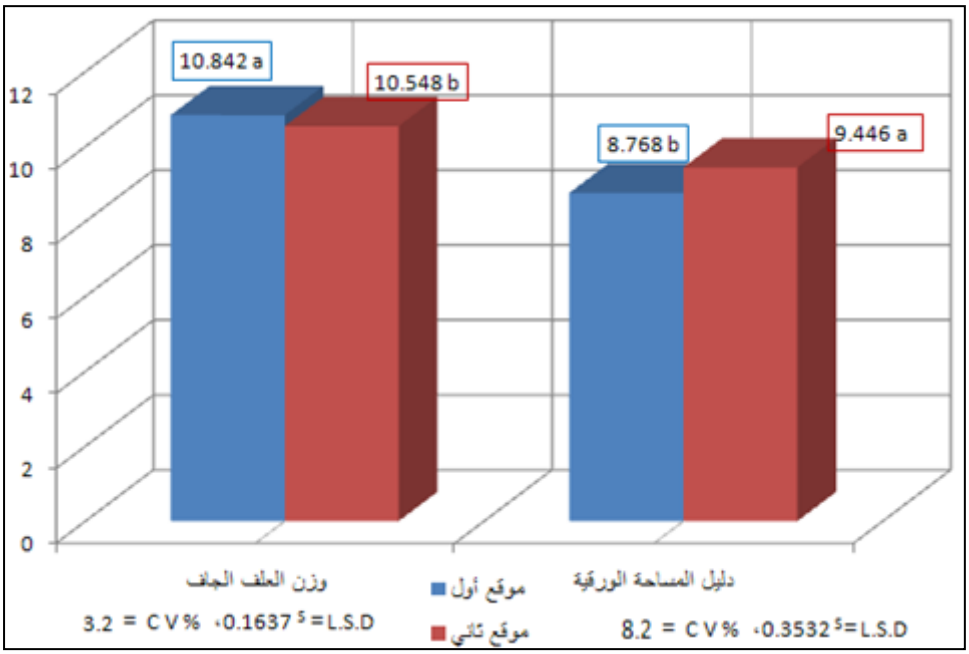

Figure (4) Means of Dry Forge Weight & LAI in Research locations

Figure (5) Means of Interaction between Varieties and Fertilizer on Dry Forage Weight

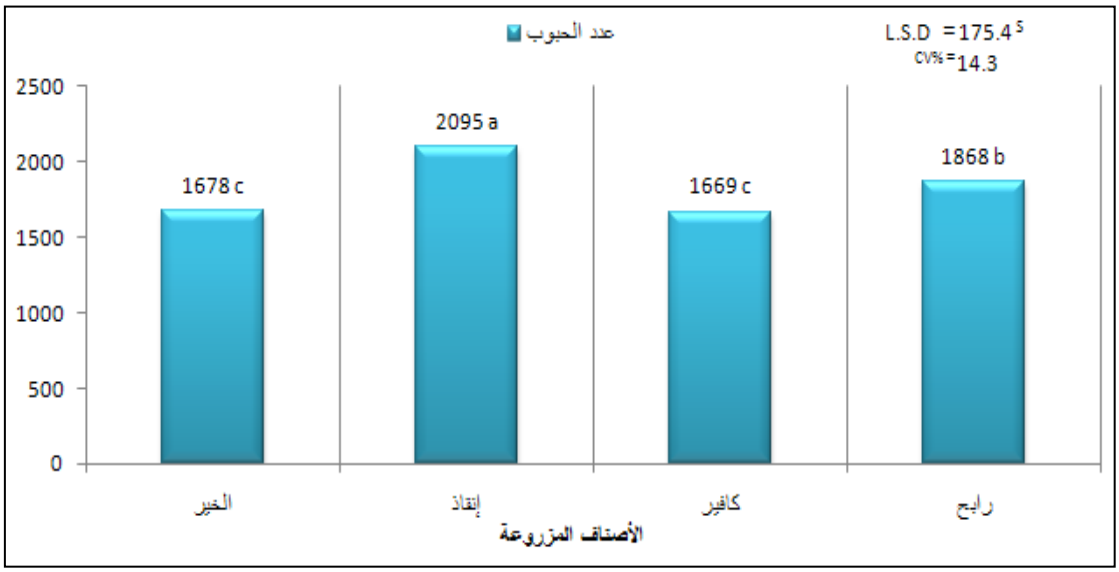

Figure (6) Means of Seed No. among Varieties

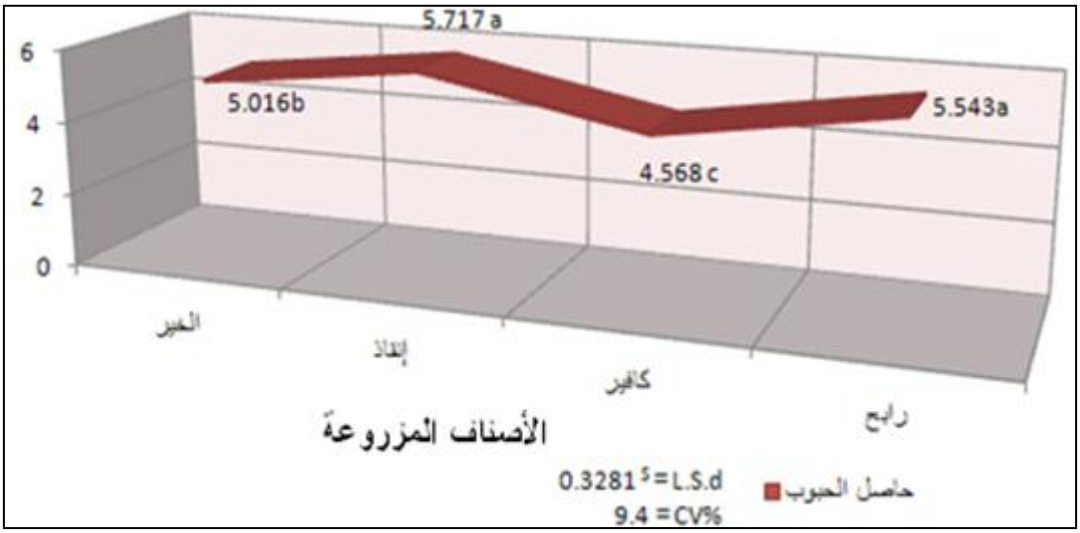

Figure (7) Means of Seed Yield among Varieties