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RESEARCH ARTICLE

Effect of nutrients management on yield attributes of fodder beet under sandy soil conditions.

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Abstract

The effect of chemical fertilizer (NK) and humic acid on top length, root length, root diameter, leaf area per plant, top fresh & dry weight and root fresh & dry weight of fodder beet *(Beta vulgaris* L. c.v voroshinger) was carried out in the Experimental Farm of Agriculture Faculty, South Valley University at Qena during the two seasons of 2016/2017 and 2017/2018 on sandy soil. A field experiment was conducted using a randomized complete block design in split- plots arrangement with three replications. Humic acid treatments were arranged in main plots while, fertilization treatments (NK) were allocated in sub-plots. The highest mean values of most previous traits were obtained from fodder beet plants which were supplemented by soil application of humic acid and 90kg N+100kg K_2O /fed. (H_1F_9). Based on these results, it is recommended to adding humic acid on soil and fertilization with NK by 90 Kg N + 100 kg K_2O per Feddan for fodder beet under similar soil and climate conditions.

Keywords: Fodder beet, Fertilization, Sandy soil

Introduction

Fodder beet (Beta vulgaris L.) is a member of the Chenopodiaceae family. Fodder beet is one of the promising winter forage crop in Egypt, especially under limited water and nutrients levels (Noreldin et al, 2016). All parts of fodder beet plant (foliage and roots) are used in animal feeding, whether directly or processed as silage (Sakr et al, 2014). The advantage of cultivating fodder beet is that it produces high economic yield in marginal lands (Abdallah and Yassen, 2008). Thus, its cultivation may help in overcoming the problem of feed shortage in Egypt during summer season (El-Sarag, 2013). Fodder beet is successfully grown as a fodder crop in many European countries and in Egypt also. The plant is used as a valuable source of fodder for cattle (Niazi, et al, 2000). Since fodder beet contains high water and sugar, it increases milk product and is suitable forage for dairy cows. The fodder beet is used by mixing with straw in European and other countries. It is also reported that the plant is suitable to make silage (Özen et al, 1993). Fodder beet has extremely high yield potential when grown on high fertile soils.

Humic acid is extracted from different sources such as soil, Humus, peat, oxidized lignite, and coal. Humic acid can directly have positive effects on plant growth and increases the growth of shoots and roots, absorption of nitrogen, potassium, calcium, magnesium, and phosphorus by plant. Humic acid is consistent with nature and is not dangerous for the plant and environment (Haghighi *et al*, 2013). Abdel-Mawgoud *et al*, (2007) states that humic acid increases plant growth through chelating different nutrients to overcome the lack of

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nutrients, and has useful effects on growth increase, production, and quality improvement of agricultural products due to having hormonal compounds.

Fodder beet requires large amounts of nitrogen. Several studies were carried out to determine the effect of Nitrogen fertilizers on fodder beet. Nitrogen fertilizers are one of the major costs for production of these crops (Abdel Gwad *et al*, 2008). Zamfir, *et al* (2001) reported that increasing nitrogen fertilization increased dry matter yield and crude protein content of fodder beet.

Potassium is an important element in plant nutrition, especially those having carbohydrate storage such as sugar beet and fodder beet, Also, K is a co-factor activating a number of important enzymes which are involved in many processes in plants such as photosynthesis, respiration and carbohydrate metabolism and translocation. Many investigators reported that K fertilizers had progressive effect on fodder or sugar beet growth and yield criteria (Gamal and Ragab, 2003). The influence of soil fertilization on nutrient content in crops has been studied and different results have been recorded. Some authors show that the application of organic amendment improves soil nutrient content, but does not always increases plant nutrient concentration.

Growth characters and yield and or yield attributes of fodder beet responded positively to the fertilization with NPK fertilizers (Abd El-All, 1990).

Therefore, the objective of this investigation was to study the effect of NK fertilization rates and Humic acid (foliar or soil application) on yield attributes of fodder beet under Qena conditions.

Materials and Methods

A field experiments was conducted in the Experimental Farm of Agriculture Faculty, South Valley University, at Qena Governorate, Egypt, during the two successive winter seasons of (2016/2017 and 2017/2018). The farm is located at an altitude of 79 m above mean sea level and is intersected by 26°10′ N latitude and 32°43′ E longitude. The experiment included three Humic acid treatments (H_0- Without Humic acid, H_1- soil application, H_2- foliar application). and nine fertilizers (NK) treatments (1- 30kg N+0kg K_2O /fed., 2- 30kg N+50kg K_2O /fed., 3- 30kg N+100kg K_2O /fed., 4- 60kg N+0kg K_2O /fed., 5- 60kg N+50kg K_2O /fed., 6- 60kg N+100kg K_2O /fed., 7- 90kg N+0kg K_2O /fed., 8- 90kg N+50kg K_2O /fed., 9- 90kg N+100kg K_2O /fed.). The soil of the experimental site is sandy soil throughout its profile (73.7 % coarse sand, 16.8 % fine sand, 5.8% silt and 3.7 % clay), with a pH value of 8.17, 0.44 EC (dSm-1), 0.89% organic matter content, 0.32% total N, 8.22 and 10.38 ppm available P and K, respectively.

The experimental design was randomized complete block design (RCBD) using split-plots arrangement with three replications. Three treatment of humic acid were distributed in main plots while, nine treatments of NK fertilization levels were allocated on the sub-plots. The experimental unit area was 9 m^2 (1/500 fad) containing 4 rows of 3 m length and 50cm between rows and 15cm between plants.

Seeds of fodder beet (*Beta vulgaris* L.) c.v. voroshinger (Hungarian) were sown at the rate of 4 kg/fed^{-1} on November 25^{th} in the 1^{st} and 2^{nd} seasons. Seeds were planted on top of the shoulder of the ridge (3 seeds per hole). After one month, the plants were thinned to 3-9 plants per hill, and then were singled to one plant per hill after 45 days from sowing, and reshowing by the removed seedlings were done simultaneously after 5-6 weeks from planting during both seasons.

Humic acid was added at the rate of 2 kg /fed. soil or foliar application after one month from sowing. Mineral fertilization nitrogen in the form of ammonium nitrate 33.5% N, and potassium in the form of potassium sulphate

48% K_2O. Treatments were added for mixing broadcasted twice doses, the first dose after one month and the second dose after two month from sowing. Triple superphosphate (15.5% P_2O_5) was added pre-planting at the rate of 150 kg/fed. before sowing. The other cultural practices were carried out as recommended for the crop.

At harvest time (5 months from sowing), when plants showed signs of maturity which is indicated by leaf yellowing and partial drying of the lower leaves, five plants were taken from each sub plot randomly hand pulled, separated into roots and tops to determine the following characters:

1) Leaves area/plant (cm^2): The disk method was followed using 100 disks of 1 cm diameter then total leaf area per plant was calculated according to blades dry weights (Watson and Watson, 1953).
2) Top length/plant (cm).
3) Top fresh weight/plant (g).
4) Top dry weight/plant (g).
5) Root length (cm).
6) Root diameter (cm).
7) Root fresh weight/plant (g).
8) Root dry weight/plant (g).

Data were analyzed by standard analysis of variance (ANOVA) were carried out according to Gomez and Gomez, (1984) using MSTAT Computer Program v.4 (1986). Means were compared using Least Significant Difference (LSD) procedures at 5% level of probability.

Results and Discussion

1- Leaves area/plant (cm^2):

Data listed in Table 1 denote that the soil application of humic acid treatment had a significant effect on leaf area/plant (cm^2) in the first season only. The application of humic acid on soil did not differ significantly from foliar spray treatment. The highest leaf area/plant (9489.16cm^2) was obtained from soil application of humic acid and the lowest leaf area/plant (6894.39 cm^2) without humic acid application in the first season. This may be due to increase the photosynthetic surface per unit area which, promoted growth and nutrient uptake of plants by addition of humic substances which affect membrane permeability. The aforementioned results generally are in good agreement with those stated by Anuja and Jayalakshmi (2011), Shaban *et al* (2014), El-gamal *et al* (2016), and Ozbay and Murat (2018).

Regarding to the effect of NK treatments, the data in Table 1 clear that the NK fertilization treatments had a significant effect on leaf area/plant (cm^2) in both seasons. Thus F9 treatment (90kg N+100kg K_2O /fed.) achieved maximum increase in leaf area/plant which was 10395.53 and 6009.65cm^2 in the first and second seasons, respectively. Whereas, minimum leaf area/plant (6810.57 and 3173.23cm^2 in the two respective seasons) were recorded from F1 treatment (30kg N+0kg K_2O /fed.). The increase in leaf area as a result high rates of NK treatments may be referred to their effect on nitrogen fixation and the uptake of nutrients hence increased fodder beet growth and development. These findings are in fully accordance with results of Geweifel and Aly (1996), Sahar (2000), Hussein and Hanan (2012), Shaban *et al* (2014), Tamiru *et al* (2017). The interaction between humic acid and NK treatment (H×F) had a significant effect on leaf area trait in the both seasons. The highest mean values of leaves area/plant (11163 and 6848 cm^2 in the two respective seasons) were obtained from fodder beet plants which were supplemented by 90 kg N and 100 kg K_2O/ fed. with humic acid soil application in the first season and by the same Nk treatment with humic acid foliar spray in the second one.

Table 1. Effects of humic acid, NK treatments and their interaction on leaf area/plant (cm²) of fodder beet in 2016-2017 and 2017-2018 seasons**.**

NK Treatments (F)	2017- 2018				2016-2017			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	2535	3815	7196	6811	5100	8135	7196	3173
F_2 (30kg N+50kg K/fed)	3174	3697	7950	7877	6360	9321	7950	3403
F_3 (30kg N+100kg K/fed)	4595	5184	11163	9555	7049	10454	11163	4724
F_4 (60kg N+0kg K/fed)	3806	3999	8508	7765	5588	9199	8508	4223
F_5 (60kg N+50kg K/fed)	4115	4454	8201	7690	6496	8374	8201	4409
F_6 (60kg N+100kg K/fed)	4938	5220	9338	9012	7699	9999	9338	5327
F_7 (90kg N+0kg K/fed)	3980	5303	8367	8318	6626	9962	8367	4831
F_8 (90kg N+50kg K/fed)	4624	5518	9263	8557	7528	8880	9263	5094
F_9 (90kg N+100kg K/fed)	4794	6387	10506	10396	9602	11078	10506	6010
Mean	4062	4842	8944		6894	9489	8944	
L.S.D 0.05								
H	NS				1226			
F	721				2339			
H x F	1148				3725			

The significant response could be attributed to a different trend of response which was observed in plants of application humic under NK treatments.

2-Top length (cm):

Data illustrated in Table 2 indicate that application of humic acid had a significant effect on top length in the second season only. Soil application of humic acid did not differ significantly with the humic acid foliar spray. Soil application of humic acid recorded the highest mean value of top length (43.1 cm) in the second season compared with control (37.3cm). This result may be ascribed to the possibility that humic substances may enhance the uptake of some nutrients. These results are in according to Anuja and Jayalakshmi (2011).

Furthermore, data presented in Table 2 reveal that increasing NK treatment levels up to 90kg N +100kg K_2O /fed significantly increased top length in both seasons. The tallest fodder beet plants (47.6 and 48.1 cm, in the two respective seasons) were obtained from F_9 treatment (90kg N +100kg K_2O /fed.). The increase in top length as a result of high levels of NK treatments may be referred to nitrogen fertilization enhanced plant capacity in protein synthesis and encouraging cell division, where, fodder beet responded positively to these building up roles of nitrogen These results are in agreement with those obtained by Sahar (2000), Turk (2010), Hussein and Hanan (2012), Kassab *et al* (2012) Khogali *et al* (2012), and Eman El-Sarag (2013).

Table 2: Effects of humic acid, NK treatments and their interaction on top length (cm) of fodder beet in 2016-2017 and 2017-2018 seasons.

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1(30kg N+0kg K/fed)	37.33	41.20	41.00	39.84	30.73	39.47	37.40	35.87
F_2 (30kg N+50kg K/fed)	39.67	42.67	42.07	41.46	32.13	41.07	39.80	37.67
F_3 (30kg N+100kg K/fed)	43.40	45.67	45.40	44.82	40.60	42.67	42.67	41.98
F_4 (60kg N+0kg K/fed)	39.00	43.00	43.33	41.77	31.07	38.93	39.20	36.40
F_5 (60kg N+50kg K/fed)	42.00	44.33	44.07	43.46	35.47	42.33	40.53	39.42
F_6 (60kg N+100kg K/fed)	45.00	46.40	46.07	45.82	41.67	46.47	43.93	44.02
F_7 (90kg N+0kg K/fed)	42.07	44.20	42.47	42.91	39.60	42.73	42.87	41.73
F_8 (90kg N+50kg K/fed)	44.33	45.80	45.40	45.17	40.53	43.33	43.67	42.51
F_9 (90kg N+100kg K/fed)	46.67	48.07	48.00	47.57	44.07	50.67	49.53	48.09
Mean	42.16	44.59	44.20		37.32	43.07	42.18	
LSD 0.05								
H	NS				1.40			
F	3.14				1.95			
H x F	5.45				NS			

Also, the interaction between humic acid application and NK treatment had a significant effect on top length in the first season only. It was clear from the obtained results that the highest mean value of top length/plant (48.1 cm in the first season) was obtained from H_1F_9 (humic acid soil application and 90kg N +100kg K_2O/fed.). While, the lowest mean value in the respect (37.3cm) was obtained from H_0F_1 (without humic acid and 30kg N + 0kg K_2O/fed.).

3-Top fresh weight /plant (g):

Data recorded in Table 3 clear that top fresh weight/plant was significantly affected by humic acid application in the both seasons. The application of humic acid on soil did not differ significantly from the foliar spray of humic acid. The greatest value of top fresh weight/plant (814.44 and 485.78g in the first and second seasons, respectively) were derived from H_2 (foliar application) and H_1 (soil application). Humic substances such as humate, humic acid and fulvic acid, play avital role in soil fertility and plant nutrition. This tendency was recorded by El-gamal *et al* (2016), Enan *et al* (2016), Nemeata Alla *et al* (2018), Ozbay and Murat (2018) and Thalooth *et al* (2019). Data collected in the Table 3 reveal that increasing NK rates from F_1 (30kg N +0 kg K_2O /fed.) to F_9 (90kg N +100kg K_2O /fed.) occurred a significant increase in top fresh weight in the both seasons. Application of F_9 gave the highest mean values of top fresh weight/plant (969.33 and 650.11g in the first and second seasons, respectively). This may be due to nitrogen affects growth and in turn on yield through its effect on cell division, expansion, and elongation resulting to large leaves and enhanced yield (Onyango, 2002). These findings were in harmony with those reported by Geweifel and Aly (1996), Abdallah and Yassen (2008), Attia et al (2011), Hussein and Hanan (2012), Kassab et al (2012) Sakr et al (2014), Abdelaal and sahar (2015) Merwad (2015), Enan et al (2016), Khatab et al (2016), Aly et al (2017), Abdel–Lateef (2018) and Nemeata Alla et al (2018) seasons.

Concerning the interaction between humic acid treatment and NK treatment (H×F) effect, data in Table 3 show significant effect on top fresh weight/plant in both seasons. The highest main values of top fresh weight/plant (1100 and 701g in the two respective seasons) were obtained from H_2F_9 and H_1F_9 respectively. Otherwise, the lowest mean values in this respect (490 and 227g) were obtained from H_0F_1treatment.

Table 3: Effects of humic acid, NK treatments and their interaction on top fresh weight/plant (g) of fodder beet in 2016-2017 and 2017-2018.

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	490	634	630	585	227	354	341	307
F_2 (30kg N+50kg K/fed)	540	701	700	647	354	363	362	360
F_3 (30kg N+100kg K/fed)	602	866	850	773	460	512	501	491
F_4 (60kg N+0kg K/fed)	500	716	700	639	320	334	341	332
F_5 (60kg N+50kg K/fed)	550	776	750	692	400	501	493	464
F_6 (60kg N+100kg K/fed)	650	949	910	836	500	594	572	555
F_7 (90kg N+0kg K/fed)	591	800	800	730	400	490	503	464
F_8 (90kg N+50kg K/fed)	650	904	890	815	444	52	543	503
F_9 (90kg N+100kg K/fed)	900	908	1100	969	600	701	650	650
Mean	608	806	814		412	486	478	
LSD 0.05								
H	142.23				42. 93			
F	60.101				71.34			
H x F	278.00				113.60			

4-Top dry weight /plant (g):

Averages of top dry weight/plant as affected by humic acid application, NK treatment and their interaction in the two seasons are illustrated in Table 4. Over NK treatment, the H_0 treatment (without humic acid) decreased evidently and significantly top dry weight/plant comparing with the application of humic acid (soil or foliar), which did not differ significantly from each other in this respect. Top dry weight/plant under H_1 surpassed those under H_0 by 30.9% in the first season. The respective percentage of increments in top dry weight/plant under H_2 over H_0 attained 43.6%. This result in accordance with that found by El-gamal et al (2016), Hoda et al (2016), Enan et al (2016) and Ozbay & Murat (2018).

(2017).

Table 4: Effects of humic acid, NK treatments and their interaction on top dry weight/plant (g) of fodder beet in 2016-2017 and 2017-2018 seasons.

NK Treatments	2016-2017	2017- 2018
	Humic acid treatments (H)	

(F)	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	55.19	73.72	79.48	69.47	25.41	42.54	38.68	35.54
F_2 (30kg N+50kg K/fed)	62.46	77.81	84.45	74.91	39.45	43.35	40.39	41.06
F_3 (30kg N+100kg K/fed)	63.19	97.25	100.86	87.10	58.14	62.26	57.61	59.34
F_4 (60kg N+0kg K/fed)	53.78	77.97	81.26	71.00	37.95	39.55	39.33	38.94
F_5 (60kg N+50kg K/fed)	58.61	74.12	87.28	73.34	44.84	55.94	57.11	52.63
F_6 (60kg N+100kg K/fed)	68.62	91.50	106.09	88.74	60.69	70.21	69.43	66.78
F_7 (90kg N+0kg K/fed)	65.78	84.90	87.35	79.34	45.13	54.58	60.40	53.37
F_8 (90kg N+50kg K/fed)	67.92	91.98	98.07	85.99	57.39	59.74	62.20	59.77
F_9 (90kg N+100kg K/fed)	92.27	100.26	118.95	103.83	65.70	80.88	81.08	75.89
Mean	65.31	85.50	93.76		48.30	56.56	56.25	
LSD 0.05								
H	16.77				NS			
F	17.01				6.63			
H x F	29.46				10.55			

Over humic acid treatments, data in Table 4 indicate that top dry weight/plant increased as NK fertilizers rates increased up to F_9 (90kg N +100kg K_2O /fed.) in the both seasons. Application of F_9 gave the highest mean values of top dry weight/plant (103.83 and 75.89g in the two respective seasons). This may be due to nitrogen affects growth and in turn on yield through its effect on cell division, expansion, and elongation resulting to large leaves. These findings were in harmony with those reported by Abdallah and Yassen (2008), Attia et al (2011), Hussein and Hanan (2012), Kassab et al (2012), Sakr et al (2014), Merwad (2015), Enan et al (2016), Khatab et al (2016) and Abdel–Lateef (2018).

The interaction between humic acid treatment and NK treatment (H×F) was significant in the both seasons (Table 4). The highest mean values of top dry weight/plant (118.95 and 81.08g in the two respective seasons) were obtained from H_2F_9. On the contrary, the lowest mean values of top dry weight/plant values (55.19 and 25.41g in the two respective seasons) were obtained from H_0F_1.

5- Root length (cm):

Data in Table 5 show that the application of humic acid on soil did not differ significantly from the foliar spray of humic acid. Root length significantly affected by humic acid application in the second season only. Soil application of humic acid significantly increased root length by 8.9 %, in the second season, compare with untreated plants. Root length in the second season affected by the level of humic acid and the longer root (29.4 cm) was obtained from humic acid soil application and the shorter (27cm) was observed without humic acid. These results are agreement with those obtained by Shaban et al (2014), Zizy Abbas et al (2014), El-gamal et al (2016), Hanan and Mohamed (2017) Ozbay and Murat (2018) and Thalooth et al (2019).

Data in Table 5 focus that NK fertilizer had a significant effect on root length in the both seasons. The high level of NK (90kg N+100kg K_2O /fed.) gave the highest mean values of root length (26.40 and 34.40 cm, in the first and second seasons respectively). Such effect of NK may be refer to its role in improving cell division and elongation which reflected on root elongation. These results are in according to Ibrahim et al (2002), Turk (2010), Albayrak and Yuksel (2010), Shalaby et al (2011), Hussein and Hanan (2012), Kassab et al (2012), Eman El-Sarag (2013), Shaban et al (2014), Abdelaal and sahar (2015), Merwad (2015), Nemeata Alla (2016), Mehanna et al (2017) and, Abdel–Lateef (2018).

The interaction between humic acid treatment and NK treatment (H×F) was significant on root length in the both seasons. The highest mean values of root length (27 and 36 cm in the two respective seasons) were obtained from soil application of humic acid and 90kg N+100kg K_2O /fed. (H_1F_9). 6- Root diameter (cm):

Data in Table 6 shows that root diameter was significantly affected by humic acid treatment in the both seasons. The application of humic acid on soil did not differ significantly with the humic acid foliar treatment regarding the root diameter, and both treatments resulted significantly higher in their root diameter than the non humic acid treatment.

Table 5: Effects of humic acid, NK treatments and their interaction on root length (cm) of fodder beet in 2016-2017 and 2017-2018 seasons.

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	18.00	20.00	20.00	19.33	19.33	23.67	23.00	22.00
F_2 (30kg N+50kg K/fed)	19.33	21.80	21.13	20.76	24.33	25.40	25.00	24.91
F_3 (30kg N+100kg K/fed)	22.20	24.00	23.00	23.07	29.33	32.00	31.00	30.78
F_4 (60kg N+0kg K/fed)	20.53	21.67	21.60	21.27	25.00	28.07	28.00	27.02
F_5 (60kg N+50kg K/fed)	22.00	23.00	22.53	22.51	25.80	28.67	28.67	27.71
F_6 (60kg N+100kg K/fed)	24.33	25.67	25.00	25.00	29.67	32.33	32.00	31.33
F_7 (90kg N+0kg K/fed)	22.47	23.00	22.60	22.69	28.80	28.67	27.33	28.27
F_8 (90kg N+50kg K/fed)	23.33	24.53	23.67	23.84	29.33	30.00	30.67	30.00
F_9 (90kg N+100kg K/fed)	25.67	27.00	26.67	26.44	31.80	36.00	35.33	34.38
Mean	21.98	23.41	22.91		27.04	29.42	29.00	
LSD 0.05								
H	NS				0.87			
F	2.92				1.83			
H x F	3.66				3.17			

Application of humic acid on soil increased root diameter by 12.6% and 17.4% in the first and second seasons, respectively compared with non-application of humic acid. These results are in good line with those obtained by Shaban et al (2014), Zizy Abbas et al (2014), El-gamal et al (2016), Enan et al (2016), Ozbay and Murat (2018), Nemeata Alla et al (2018), Thalooth et al (2019) and Kandil et al (2020).

As for NK treatments, data in Table 6 indicate that NK had a significant effect on root diameter in the both seasons. The high levels of nitrogen and potassium treatment (F_9) surpassed significantly all other NK treatments. Applied of 90kg N + 100kg K_2O /fed increased root diameter by 48.9% and 59.5% in the first and second seasons, respectively compared with the law rate of nitrogen and potassium (30kg N+0kg K_2O /fed.). These results are in accordance with those obtained by Ibrahim et al (2002), Abdallah and Yassen (2008), Turk (2010), Albayrak and Yuksel (2010), Shalaby et al (2011), Hussein and Hanan (2012), Kassab et al (2012), Khogali et al (2012), Eman El-Sarag (2013), Shaban et al (2014), Abdelaal and sahar (2015), Merwad (2015), Enan et al (2016), Nemeata Alla (2016), Aly et al (2017), Mehanna et al (2017), Abdel–Lateef (2018) and Nemeata Alla (2018).

The interaction between humic acid treatment and NK treatment (H×F) exhibited significant for root diameter in the both seasons. The highest mean values of root diameter (14.50 and 14.30 cm in the two respective seasons) were obtained from H_1F_9 in the both seasons. The significant response could be attributed to a different trend of response which was observed in plants of application humic acid under NK treatments.

7- Root fresh weight/plant (g):

Results given in Table 7 indicate that the application of humic acid on soil did not differ significantly with the humic acid foliar treatment. Soil application of humic acid significantly increased root fresh weight by 65.6% in the second season, compare with untreated plants. Humic acid application (soil or foliar) failed to be significant at 5% level of probability in the first season. These results may be due to that humic substances enhance the uptake of some nutrients, and improve the plant resistance to salinity. These results are explaining with those reported by Shaban *et al* (2014), Zizy Abbas *et al* (2014), El-gamal *et al* (2016), Enan *et al* (2016), Hoda *et al* (2016), Nemeata Alla *et al* (2018), Ozbay and Murat (2018) and Thalooth *et al* (2019).

Data collected in the Table 7 reveal that increasing NK rates from N30K0 kg/fed.to N90K100 kg/fed occurred a significant increase in fresh weight of root in the both seasons. Application of 90kg N+100kg K_2O /fed gave the highest mean values of root fresh weight (2299.78 and 1793.00g/plant in the first and second seasons, respectively). This may be due to nitrogen affects growth and in turn on root weight through its effect on cell division, expansion, and elongation resulting to large leaves and enhanced root weight/plant. These findings were in harmony with those reported by Geweifel and Aly (1996), Abdallah and Yassen (2008), Attia *et al* (2011), Shalaby *et al* (2011), Hussein and Hanan (2012), Kassab *et al* (2012), Sakr *et al* (2014), Shaban *et al* (2014), Abdelaal and sahar (2015), Merwad (2015), Enan *et al* (2016), Khatab *et al* (2016), Aly *et al* (2017), Abdel–Lateef (2018) and Nemeata Alla (2018). The interaction between humic acid treatment and NK treatment (H×F) was significant regarding root fresh weight trait in the both seasons (Table 7). The highest mean values of root weight/plant (2700.67 and 2086.33 g/plant in the two respective seasons) were obtained from H_1F_9. These findings are in harmony with Enan *et al* (2016).

Table 6: Effects of humic acid, NK treatments and their interaction on root diameter (cm) of fodder beet in 2016-2017 and 2017-2018 seasons.

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 Without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	9.00	9.26	9.38	9.21	7.10	9.12	9.01	8.44
F_2 (30kg N+50kg K/fed)	9.41	9.85	9.68	9.65	8.03	9.31	9.30	8.91
F_3 (30kg N+100kg K/fed)	10.52	11.94	11.84	11.43	9.01	9.81	9.93	9.58
F_4 (60kg N+0kg K/fed)	9.50	10.67	11.50	10.59	8.19	9.90	9.90	9.34
F_5 (60kg N+50kg K/fed)	10.11	11.33	11.53	10.99	9.41	10.30	10.00	9.90
F_6 (60kg N+100kg K/fed)	11.67	13.41	13.50	12.86	10.00	11.02	10.93	10.65
F_7 (90kg N+0kg K/fed)	9.95	11.33	11.00	10.76	9.05	11.44	11.00	10.47
F_8 (90kg N+50kg K/fed)	10.50	12.01	12.01	11.51	10.34	12.20	11.51	11.35
F_9 (90kg N+100kg K/fed)	12.37	14.50	14.20	13.69	12.02	14.30	13.83	13.38
Mean	10.34	11.59	11.63		9.21	10.83	10.60	
LSD 0.05								
H	0.43				0.32			
F	0.62				0.72			
H x F	1.10				1.25			

Table 7: Effects of humic acid, NK treatments and their interaction on root fresh weight/plant (g) of fodder beet in 2016-2017 and 2017-2018

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	1095	1735	1745	1525	766	1214	1201	1060
F_2 (30kg N+50kg K/fed)	1275	1955	1900	1710	908	1626	1600	1378
F_3 (30kg N+100kg K/fed)	1498	2141	2123	1921	1102	1840	1799	1580
F_4 (60kg N+0kg K/fed)	1316	1831	1857	1668	824	1340	1340	1168
F_5 (60kg N+50kg K/fed)	1424	1900	1880	1735	908	1467	1340	1258
F_6 (60kg N+100kg K/fed)	1580	2293	2141	2004	1098	1907	1840	1615
F_7 (90kg N+0kg K/fed)	1393	1925	1911	1743	866	1399	1420	1228
F_8 (90kg N+50kg K/fed)	1475	2215	2089	1926	1033	1640	1673	1449
F_9 (90kg N+100kg K/fed)	1761	2701	2437	2300	1266	2086	2027	1793
Mean	1424	2078	2009		974	1613	1589	
LSD 0.05								
H	NS				481.40			
F	357.00				246.90			
H x F	569.40				393.20			

8- Root dry weight/plant (g):

Data in Table 8 indicate that humic acid treatments had a significant effect on root dry weight/plant in the both seasons. Application of humic acid on soil did not differ significantly with the humic acid foliar treatment. Application humic acid significantly increased root dry weight by 43.9% and 83.9% in the first and second seasons, respectively, compare with untreated plants. These results are in line with those reported by Shaban *et al* (2014), Zizy Abbas *et al* (2014), El-gamal *et al* (2016), Enan *et al* (2016), Hoda *et al* (2016) and Ozbay and Murat (2018).

Data collected in the Table 8 reveal that increasing nitrogen and potassium fertilizers rates from N30K0 kg/fed. to N90K100 kg/fed. occurred a significant increase in dry weight of root in the two seasons. Application of F_9 (90kg N +100kg K_2O /fed.) gave the highest mean values of root dry weight/plant (351.44 and 238.90 g/plant in the first and second seasons, respectively). The increase in plant dry weight due to increasing nitrogen rate may be attributed to synergistic effect of nitrogen on vegetative growth, number and area of leaves as well as photosynthesis rate which increased dry matter accumulation and stored in root. Also, potassium fertilizer amount led to positive effect on physiological processes such as respiration, transpiration, enzyme reaction and cells turgidity of plant size and growth and activity of meristemic tissues responsible for elongation. These results are in full accordance with those reported by Abdallah and Yassen (2008), Attia et al (2011), Hussein and Hanan (2012), Kassab et al (2012), Sakr et al (2014), Shaban et al (2014), Merwad (2015), Enan et al (2016), Khatab et al (2016). In the two growing seasons, the interaction between humic acid treatment and NK. In the two growing seasons, the interaction between humic acid treatment and NK treatments had a significant effect on root dry weight in the both seasons (Table 8). In the first season, the highest mean value of root dry weight (431.37g/plant) was produced from H1F9. Where, H2F9 gave the highest mean value of root dry weight (307.09g/plant) in the second season. These findings are in harmony with Enan et al (2016).

Table 8: Effects of humic acid, NK treatments and their interaction on root dry weight/plant (g) of fodder beet in 2016-2017 and 2017-2018 seasons.

NK Treatments (F)	2016-2017				2017- 2018			
	Humic acid treatments (H)							
	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean	H_0 without humic acid	H_1 Soil application	H_2 foliar application	Mean
F_1 (30kg N+0kg K/fed)	182	283.	267	244	890	166	169	141
F_2 (30kg N+50kg K/fed)	203	305	272	260	103	244	246	197
F_3 (30kg N+100kg K/fed)	226	322	315	288	125	263	252	214
F_4 (60kg N+0kg K/fed)	209	292	283	261	106	179	185	157
F_5 (60kg N+50kg K/fed)	220	294	296	270	122	178	194	165
F_6 (60kg N+100kg K/fed)	239	347	319	302	152	266	223	214
F_7 (90kg N+0kg K/fed)	213	266	306	262	118	178	206	167
F_8 (90kg N+50kg K/fed)	233	335	311	293	129	207	230	189
F_9 (90kg N+100kg K/fed)	275	431	348	351	149	261	307	239
Mean	222	320	302		122	216	224	
LSD 0.05								
H	85.95				65.00			
F	60.32				46.00			
H x F	96.04				73.89			

Conclusion:

The highest mean values of previous traits were obtained from the application of humic acid on soil compared with no application of humic acid. In addition, the highest values of top length, root length, root diameter and LA, top fresh & dry weight and root fresh & dry weight were obtained from F9 (90 Kg N/fed + 100 kg K2O/fed). It is recommended to adding humic acid on soil and fertilization with NK by 90 Kg N and 100 kg K2O per feddan for fodder beet under similar soil and climate conditions.

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