The Response of Yield and Morphological Traits of Fodder Beet (*Beta vulgaris* var. *crassa* Mansf.) to Nitrogen Fertilization

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Abstract

Fodder beet is a very important source of forage in Syria and over the world, because of its high yield and nutritional value for animals. The experiment was conducted at Research Center of Homs, General Commission for Scientific Agricultural Research, Syria, during two successive seasons 2019 and 2020, to study the effect of four levels of nitrogen fertilization viz. 100, 200, 300 and 400 N kg/ha in the form of urea on yield and morphological traits of fodder beet. Vermon variety was used, and the experiment was designed according to Randomized Complete Block design (RCBD) with three replicates. The results showed that adding 200 N kg/ha which equal 440 kg/ha urea, increased significantly root diameter (20.02 cm), root length (37.38 cm), root dry weight/plant (206.0 g), root fresh weight/plant (1376 g), top dry matter percentage (10.73%), top dry weight (73.87 g) and top fresh weight (687.7 g). According to the aforementioned results it is recommended to add 440 kg/ha urea to get the highest yield and morphological traits.

Key words: Fodder beet, Nitrogen fertilization, Dry matter, Morphological traits.

Introduction:

Fodder beet (*Beta vulgaris var.Grassa)*, is a member of the Chenopodiaceae family, and this forage crop is native to Mediterranean area and was grown as a root crop in Germany and Italy as early as the sixteenth century. It is world-wide in temperate zones up to 55o N (Al Jbawi, 2020).

There is renewed interest in fodder beet (*Beta vulgaris* L.) production in Syria, especially a strong interest toward the use of fodder beet for autumn and winter feeding of dairy herds (Al-Jbawi *et al*., 2014).

The production of forage crops is very important for livestock production in the world, which contributes largely to the national income (Mohanna *et al*., 2019). Animal production in the Syria depends mainly on natural range which is affected by the seasonal rains and low-quality grasses, this necessitates the introduction of irrigated forage crops in the irrigated schemes. There are many constrains facing forage production in Syria, like lack of information of fodder beet which considered as a new crop (AL Jbawi *et al*., 2019). Suggested solutions for these problems are application of technological packages, integration of animal production with forage production and introduction of new forage species of high yield (Khair, 1999) especially during periods of forage shortage like late winter and early summer (Al-Jbawi, 2020).

Fodder beet offers a higher yield potential than any other arable fodder crop (Anonymous, 2006), and when grown under suitable conditions can produce almost 20 t/ha^{-1} dry matter yield (DAF, 1998), and this makes it popular in many countries like New Zealand, Germany, America, Australia, Syria and Egypt (Shalaby *et al*., 1989). It contains 10-15% dry matter and may yield more than 20 t/ha of dry matter in one harvest as compared to 13-15 t/ha from four cuts of grass (Kiely *et al*., 1991).

Nitrogen is a vital element for plant growth as it is a component of protein and chlorophyll, it is often the most limiting factor in crop production. Hence, application of fertilizer nitrogen results in higher biomass yield (Blumenthal *et al.*, 2008).

Chakwizira *et al*., (2014) studied the effects of N supply on growth, N uptake and its influence on nutritive value of fodder beet, they found that both dry matter (DM) yield and N uptake increased with N supply, by 39% and 129%, respectively, when 200 kg N ha^{-1} was applied, compared with the control plots. The results suggest 100 kg N ha^{-1} was adequate for optimum DM production, while Turk, (2010) found that the highest root yield and crude protein yields were obtained from 225 kg ha^{-1}N under Turkey conditions.

Amongst the dicot plant families, the *Beta* spp. are known for their high sensitivity to boron deficiency (Martens and Westermann, 1991).

The aim of the present study is to investigate the effects of nitrogen fertilization rates and foliar boron application on root yield, quality and dry matter yield of fodder beet.

Materials and Methods:

The experiment was carried out during two successive winter seasons of 2018/2019-2019/2020, at Homs Agricultural Research Center, General Commission for Scientific Agriculture Researches (GCSAR), Syria. The site has a latitude of 34.7324º N, and longitude of 36.7137º E. The soil of the experimental site is clay silty, characterized by low nitrogen content (5.4-6.5 ppm) and pH of (7.5-8.1), Ec (0.34-0.32 dS.m^{-1}), organic matter (1.38-1.41) and boron (0.44, 0.38 ppm) at the first and second seasons respectively.

Phosphorus as triple superphosphate (46% P_2O_5) at a rate of 160 kg/ha, and potassium as potash sulfate (50% K_2O) were added at a rate of 120 kg/ha before planting as agronomic practice. Nitrogen fertilization in the form of urea (46% N) was applied at four rates as follow, 100 (N1), 200 (N2), 300 (N3) and 400 (N4) kg N/ha. The total amount was divided into three doses (the first added at planting, the second added after thinning and the third after one month following the second dose according to the recommendations of Abbas *et al*., (2018). Boron was sprayed on fodder beet foliage after 110 and 140 days from sowing at a form of borax (10 % B). Climatic data are given in Table (1).

Table 1. Temperatures and rainfall distribution during 2018/2019 and 2018/2020 seasons

Months	Total rainfall (mm)		Max. temperature (°C)		Min. temperature (°C)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
January	131.3	115	11.43	11.7	3.97	4.45
February	121.7	69.7	13.67	12.34	5.26	4.66
March	51.5	59.2	16.52	18.10	7.82	8.52
April	27.5	47.3	19.68	21.31	9.38	11.14
May	0.0	11.3	30.51	27.29	15.94	14.64
June	0.1	0.0	32.32	30.82	20.67	18.52
July	0.0	0.0	32.62	31.86	21.97	20.58

At harvest (6 months from sowing), when plants showed signs of maturity which is indicated by leaf yellowing and partial drying of the lower leaves, a sample of 10 plants of each experimental plot was taken from the inner two ridges randomly hand-pulled to determine: Root length and diameter (cm), root and top fresh and dry weight (g) and root and top dry matter percentage (%).

Statistical analyses:

Analysis of variance (ANOVA) appropriate for the completely randomized block design with two factors was applied. The treatment means were compared using least significant difference (LSD) procedures at 5% level using GeneStat Computer Program v.12.

Results and Discussion:

Root diameter and length (cm):

The effect of nitrogen fertilization is significant on root diameter and length, which increased with increasing nitrogen dose up to N3 (300 kg N/ha), so the highest root diameter and length (20.54 and 37.97 cm) were obtained from the treatment N3 respectively (Table 2).

Table 2. Effect of nitrogen fertilization on root diameter and length (cm)

Nitrogen fertilization (N)	Root diameter cm	Root length cm
N100	19.30^{c}	15.56
N200	20.03^{ab}	14.97^{a}
N300	20.54^{a}	14.34^{b}
N400	19.82^{bc}	13.63^{c}
Mean	**19.93**	**14.62^{d}**
CV	**3.9**	**2.0**
$LSD_{0.05}$	**0.65**	**0.24**

Fresh root and top weight/plant (g):

The combined analysis of the two seasons; root and top weight per plant also significantly increased from N200 to N300 (Table 3).

These results are consistent with those reported by Zaki (1999), Abdel-Gawad *et al.*, (2008), Abbas *et al*., (2014), Dewdar *et al.*, (2015), and Abbas *et al*., (2018). The increase in root and shoot weight per plant as a result of increasing nitrogen fertilizer levels may be due to the role of nitrogen in increasing vegetative growth, fresh root and shoot weight (Blumenthal *et al.*, 2008).

Table 3. Effect of nitrogen fertilization on fresh root and top weight (g)

Nitrogen fertilization (N)	Fresh root weight /plant g	Fresh top weight/plan g
N100	1181[c]	597.8[c]
N200	1376[a]	687.7[a]
N300	1349[a]	695.0[a]
N400	1277[b]	621.3[b]
Mean	1296	650.5
CV	**5.6**	**4.1**
$LSD_{0.05}$	**60.1**	**21.9**

Dry matter weight/plant (g) of root and top:

Root dry matter weight for root and top was significantly increased as nitrogen rate increased to N3 (300 Kg N/ha). The highest root dry weight per plant was obtained by adding 200 Kg N/ha (206.0 g), while the highest value of top dry weight was obtained by adding 300 Kg N/ha (695.0 g) (Table 4).

Table 4. Effect of nitrogen fertilization on dry root and top weight (g)

Nitrogen fertilization (N)	Dry root weight /plant g	Dry top weight/plant g
N100	183.8[b]	65.71[b]
N200	206.0[a]	73.87[a]
N300	193.4[b]	73.27[a]
N400	174.0[c]	60.68[c]
Mean	189.3	68.38
CV	**6.2**	**7.9**
$LSD_{0.05}$	**9.6**	**4.5**

This increase in dry matter could be attributed to the role of nitrogen in enhancing plant growth and consequently accumulation of more assimilates (Ibrahim *et al*., 2005), and to the increase in the amount of metabolites synthesized by plants due to the effect of nitrogen in enhancing photosynthesis and hence dry matter accumulation. These results are consistent with the findings of Nemeat Alla *et al*., (2002), Nafei (2004) and Khogali *et al*., (2011).

Dry matter percentage (%) of root and top:

Table (5) shows a significant difference between nitrogen fertilization treatments, and the highest value for root was achieved by the addition of 100 Kg N/ha, while for top dry matter percentage, the highest values were achieved for 100 and 200 Kg N/ha with no significant differences (10.98 and 10.73%) respectively.

Table 5. Effect of nitrogen fertilization on dry matter percentage (%) of root and top

Nitrogen fertilization (N)	Dry matter percentage of root (%)	Dry matter percentage of top (%)
N100	15.56[a]	10.98[a]
N200	14.97[b]	10.73[ab]
N300	14.34[c]	10.53[b]
N400	13.63[d]	9.76[c]
Mean	14.62	10.50
CV	**2.0**	**5.0**
$LSD_{0.05}$	**0.24**	**0.43**

Conclusion:

Nitrogen fertilization improved yield and morphological traits of fodder beet, and had significant positive effects on root length and diameter (cm), root and top fresh and dry weight (g) and root and top dry matter percentage (%). The highest yield and morphological traits were associated with 200 kg N/ha. So, it can be recommended to be the optimum rate under Homs governorate conditions.

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