پاسخ برخی از صفات عملکردی و کیفی چغندر علوفه‌ای (*Beta vulgaris* L.) به کودهای آلی و پتاسیمی در سوریه

The Response of Some Productivity and Quality Traits of Fodder Beet (*Beta vulgaris* L.) to Organic and Potassium Fertilizers in Syria

انتصار الجباوی[1*]، سمیر شمشام[2] و حیبا شمس الدین حیبا[2]

تاریخ دریافت: ۹۷/۰۲/۰۸ ؛ تاریخ پذیرش: ۹۷/۰۵/۱۰
DOI:10.22092/jsb.2017.108514.1135

چکیده

چغندر علوفه‌ای (*Beta vulgaris* L.) به عنوان یک محصول علوفه‌ای در سوریه مورد توجه می‌باشد. با این حال اقدامات زراعی توصیه شده جهت افزایش عملکرد آن محدود هستند. این مطالعه در تاریخ ۱۰ شهریور سال زراعی ۹۶-۱۳۹۵ به منظور بررسی تأثیر کودهای آلی و پتاسیمی بر روی صفات عملکردی چغندر علوفه‌ای انجام شد. آزمایش به صورت اسپلیت پلات (کرت‌های خرد شده) بر پایه بلوک های کامل تصادفی با سه تکرار انجام شد. تیمارهای کودآلی (شاهد، کود حیوانی، عصاره جلبک دریایی) به کرت‌های اصلی اختصاص داده شدند. در حالی که تیمارهای پتاسیم به میزان ۹۰، ۱۲۰ و ۱۶۰ واحد اکسید پتاسیم خاص در هکتار به طور تصادفی در کرت های فرعی توزیع شدند. نتایج تجزیه واریانس نشان دادند که تیمار پتاسیم بر روی وزن ریشه و اندام هوایی هر بوته و بر روی پروتئین خام ریشه و اندام هوایی اثر معنی‌دار ($P\leq0.05$) داشته است. بهترین تیمار برای دستیابی به بالاترین عملکرد در کیفیت مقدار ۹۰ کیلوگرم در هکتار بود. در میان تیمارهای کودآلی، عصاره جلبک دریایی نسبت به دیگر تیمارها برتی معنی‌دار داشت.

واژه‌های کلیدی: چغندر علوفه‌ای، سوریه، کود آلی، کود پتاسیمی، کشت تابستانه

Introduction

Fodder beet (*Beta vulgaris* L.) is a member of the *Chenopodiaceae* or goosefoot family. Fodder beet, also called mangold, mangel, or mangel-wurzel is grown for its nutritious tops and roots that are used as animal feed (Khair 1999).

The production of forage crops is very important for livestock production in Syria, which contributes largely to the national income. Animal production in Syria depends mainly on natural range which is affected by rain fluctuations and low-quality grasses. This necessitates the introduction of irrigated forage crops in the irrigated schemes and in farms around cities like Damascus. There are many constrains limiting forage

۱ - استادیار بخش چغندرقند- سازمان تحقیقات کشاورزی، دمشق، سوریه. *- نویسنده مسئول dr.entessara@gmail.com
۲ - دانشجوی گروه خاکشناسی، دانشگاه البات، حمص، سوریه.

production in Syria, like lack of information of forage cultivars and technological packages. 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 (Al Jbawi 2014), especially during periods of forage shortage like late winter and early summer.

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 also yields more than 80 t. ha^{-1} 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 20 t. ha^{-1} of dry matter in one harvest as compared to 13-15 t. ha^{-1} from four cuts of grass (Kiely *et al.* 1991).

Beet is a high energy, low protein, and low fiber feed. It is treated as a forage concentrate as it digests very quickly in the rumen (Al Jbawi 2014). Fodder beet has many advantages as compared to sugar beet , For example, soil contamination at harvest is usually lower than with sugar beet but depends on variety choice. The softer varieties tend to grow higher out of the ground and have fewer grooves in the root, and therefore retain less soil, huge dry matter (DM) yields with expected protein to be 1-2% higher. With soft fodder beet varieties, you have the option of grazing in the field and fodder beet will have lower soil contamination and will reduce the need to wash roots before feeding.

The above and below growth parts (leaves and roots) are used to feed the animals but, the main fodder is tuberous roots (Ibrahim 2005; El-Sarag 2013). Beet should be chopped as this greatly increases intakes and is very important for younger cattle and for sheep. Beet is a high palatable and highly digestible feed and in a properly balanced diet it should result in excellent animal performance and more efficient milk and meat production (Niazi *et al.* 2000).

Fodder beet can thrive on a wide range of soils but a light to medium, free draining field is ideal. The target pH of soil is 7 and good accessibility is vital for heavy harvesting machinery. Monogerm seed has eliminated the need for labour intensive singling.

As the crop can take over 200 days to mature, later sown crops will not have enough time to fully develop before winter which will limit yield (Pembleton and Rawnsley 2011).

Recent research suggests high dry matter (DM) yields of 19–35 $tDM.ha^{-1}$ (Chakwizira *et al.* 2012; Matthew *et al.* 2011) are attainable in New Zealand. These DM yields are higher than the 10–15 $tDM.ha^{-1}$ for the traditional winter crops, e.g., kale and swedes (Chakwizira *et al.* 2011; Gower *et al.* 2006; Wilson *et al.* 2006).

Growth characters and yield and or yield attributes of fodder beet responded positively to the fertilization with NPK fertilizers (Abd allah and Yassen 2008 and Šrek *et al.* 2010). Potassium plays a vital role in: photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata and water use, activation of plant enzymes and, many other processes (Marschner 1995; Reddya *et al.* 2004). Chakwizir *et al.* (2012) conducted two experiments investigating the effects of different rates of potassium (K; 150 or 300 $kg.ha^{-1}$), fertiliser application on fodder beet dry matter (DM) production, and found that the final DM yield was unaffected by the treatments averaging 21 to 32 $tDM.ha^{-1}$. Also, potassium tended to depress crude protein, neutral detergent fibre and ash content of the bulbs and increase the metabolizable energy and soluble sugar. They observed that the combination of low fibre and high soluble sugar concentrations puts animals at risk of rumen acidosis. These results suggest that fodder beet crops subjected to high rate of soil and/or fertiliser K should be supplemented with feed high in crude protein and fibre.

Turk (2012) conducted a research to determine the effect of three potassium doses (0, 50 and 100 kg K_2O/ha) on root yield and yield components of fodder beet. It was determined that the effect of fertilization was significant for all parameters except root dry matter content.

Seaweeds and seaweed products are increasingly used in crop production. Further, seaweed extracts are considered an organic farm input as they are environmentally benign and safe for the health of animals and humans (Khan et al. 2009). Seaweed components such as macro- and microelement nutrients, amino acids, vitamins, cytokinins, auxins, and abscisic acid (ABA)-like growth substances affect cellular metabolism in treated plants leading to enhanced growth and crop yield (Durand *et al.* 2003; Stirk *et al.* 2003; Ordog *et al.* 2004). Plants sprayed with seaweed extracts also exhibit enhanced salt and freezing tolerance (Mancuso *et al.* 2006).

Fodder beet is a good forage, especially during the critical period of forage shortage such as early summer season in Syria. There is also limited information on the nutritive qualities of fodder beet crop in Syria. The objective of this study was to study the effects of organic and potassium fertilizers on yield and quality traits of fodder beet to provide information on cultural practices concerning this important crop under Syrian conditions.

Materials and Methods

A field experiment was conducted on summer season of September (2016/2017), in Homs Agricultural Research Center, General Commission for Scientific Agricultural Research (GCSAR), Syria. The location coordinates are Latitude 34 ° 43′ N and Longitude 36 ° 42′ E). The soil of the experimental site is sandy clay, characterized by high nitrogen content (44.9 $mg.kg^{-1}$) and pH of 8.33 (Table 1). Two-factor experiment was conducted in a split plot arrangement based on a randomized complete block design (RCBD) with three replications. The main plots were allotted to organic fertilizer (control, manure, seaweeds extracts), and the sub-plots to the potassium fertilizer (90, 120, and 160 pure unit of $K_2O.ha^{-1}$). The variety Vermon (French cultivar) was used. The land was disc- ploughed, harrowed twice, leveled and ridged 60 cm apart, with 30 cm space between holes. The size of the plot was 6×3 m, consisting of six rows of 6m length. The seeds were sown manually on the shoulder of the row at a rate of 4.6 $kg.ha^{-1}$ (three seeds per hole) on September 1^{st}.

The crop was irrigated at 7-10-day intervals depending on the temperature, relative humidity and soil moisture conditions. (K_2O) was added pre-planting at rates according to the studied treatments of (90, 120, and 160kg pure unit of $K_2O.ha^{-1}$). Hand thinning to one plant per hole and re-planting by the removed seedlings were done simultaneously after 5-6 weeks from planting. Manual weeding was done 5 weeks after planting.

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 five plants of each plot was taken from the inner two rows and randomly hand-pulled to determine root weight/plant (g), shoot weight/plant (g), dry matter content (%), and crude protein content (%) of shoot and root according to Kjeldahl method. Three inner rows were harvested to determine root and shoot $yield.ha^{-1}$.

The temperatures during harvest in spring reached 17°C, while the lowest temperature reached approximately 8°C (Table 2).

Table 1 Soil properties of the experimental location during 2016/2017 season

Particle size distribution			Texture Class	Available phosphor ($mg.Kg^{-1}$)	Available nitrogen ($mg.Kg^{-1}$)	Available potassium ($mg.Kg^{-1}$)	Chemical analysis of soil paste extraction		
Sand (%)	Silt (%)	Clay (%)					$CaCo_3$ (%)	E.C ($mmhos.cm^{-1}$, $25C^0$)	PH Soil paste
35.6	15.3	49.1	Sandy clay	16.0	44.9	377.0	32.7	0.3	8.33

Analysis of variance (ANOVA) appropriate for the split plot design was applied (Gomez and Gomez, 1984). The treatment means were compared using Least Significant Difference (LSD) procedure at 5% level using GenStat Computer Program v.12.

Table 2 Temperatures and rainfall distribution during 2016/2017 season

Month	Max. Temperature (°C)	Min. Temperature (°C)	Rainfall (mm)
September	30.157	19.66	-
October	28.60	15.35	-
November	20.32	6.4	4.3
December	9.81	3.44	120.9
January	10.34	2.65	92.7
February	12.28	2.43	7.4
March	17.27	7.93	50.9

Source: Meteorology Station in Homs governorate.

Results and Discussion

Root weight/ plant

Table (3) illustrates the effect of organic and potassium fertilizers on root weight/plant. This trait was greater under the addition of seaweeds extracts (O_3)(1800 g) as compared with the addition of manure (O_2) (1633 g) ($P \leq 0.05$). Potassium levels significantly ($P \leq 0.05$) affected root weight/plant. The addition of K90 resulted in the highest root weight/plant (1705 g), followed by K120 (1613 g) with no significant differences, then K160 (1577 g) ($p \leq 0.05$).

Shoot weight/plant

Table (3) contains the data concerning the effect of organic and potassium fertilizer rates on shoot weight per plant. It is clear from Table (2) that potassium treatments have significant effect on this trait. K120 had the highest value (1394 g) followed by K90 (1468 g) with no significant differences, while the lowest value was achieved by K160 (1349 g). These results coincided with those reported by Omar *et al.* 2002; Attia 2004; El-Kholy *et al.* 2006; Abdel Motagally and Attia 2009, which could be attributed to the stimulatory effect of K on rate of photosynthesis, as well as, transport of the photosynthetic product from the leaves to the storage root.

Root yield

The application of organic fertilization had a significant effect on root yield; seaweed extracts increased root yield. But the differences in root yield regarding K additions were not significant (Table 3). The highest root yields (58.50 $t.ha^{-1}$) were obtained from sea weed extracts application. Abdel-Gawad *et al.* (2008) reported that fertilization increased average root yield of fodder beet. These results are consistent with the present results. This could be explained by the fact that seaweed components in treated plants led to enhanced growth and crop yield (Durand *et al.* 2003; Stirk *et al.* 2003; Ordog *et al.* 2004).

Shoot yield

Table (3) shows that fertilization applications had no significant effects on shoot yield of fodder beet. But the interaction of organic fertilizer × potassium was significant indicating the magnitude effect of both fertilizers on this trait. The highest shoot yield (50.26 $t.ha^{-1}$) achieved with the addition of seaweed extracts and K120.

Table 3 The effect of organic and potassium fertilizers on root and shoot weight. $plant^{-1}$ (Kg), root and shoot yields (tha^{-1}) of fodder beet

Organic Fertilizer (O)	Potassium Fertilizer (P)	Root weight. $plant^{-1}$ (g)	Shoot weight. $plant^{-1}$ (g)	Root yield ($t.ha^{-1}$)	Shoot yield ($t.ha^{-1}$)
Control (no addition) (O_1)	K90	1487	1294	52.48	45.54
	K120	1446	1372	52.48	49.42
	K160	1451	1389	48.59	46.65
Mean		1461 c	1352 a	51.18 b	47.20 a
Manure (O_2)	K90	1877	1665	54.42	48.59
	K120	1519	1271	45.81	38.32
	K160	1501	1287	46.93	40.26
Mean		1633 b	1407 a	49.05 b	42.39 a
Seaweeds extracts (O_3)	K90	1750	1446	56.09	46.37
	K120	1873	1540	61.09	50.26
	K160	1777	1372	58.31	44.98
Mean		1800 a	1453 a	58.50 a	47.20 a
Average of potassium	K90	1705 a	1468 a	54.33 a	46.83 a
	K120	1613 ab	1394 ab	53.13 a	46.00 a
	K160	1577 b	1349 b	51.28 a	43.96 a
Mean		1632	1404	52.91	45.60
LSD (O) 0.05		82.9*	128.6 ns	5.42*	5.48 ns
LSD (P) 0.05		112.9*	108.2*	4.35 ns	3.88 ns
LSD (O*P) 0.05		168.6*	178.5**	7.30	6.83*
CV%		6.7	7.5	8.0	8.3

ns: Not significant, at 0.05 level of probability.

Root dry matter content

Organic fertilization applications had significant effect on DM content of fodder beet (Table 4), while potassium rates had non-significant effect on root DM. Bieniaszewski *et al.* (1995) reported that root DM content was not affected by potassium rates. This result is consistent with the present results. Prokopenko *et al.* (1997) and Khan *et al.* (2009) found that dry matter content of the fodder beet increased directly with the level of fertilization. The root DM yield exhibited a similar trend to root yield. The O_3K90 treatment resulted in the highest root DM content (14%).

Shoot dry matter content

Organic fertilization applications had significant effect on shoot DM content of fodder beet (Table 4), while potassium rates had non-significant effect on shoot DM. The O_3K90 treatment resulted in the highest root DM content (15%) ($P \leq 0.05$).

Root crude protein content

The highest root crude protein (CP) content was obtained from O_3 application (14.66 %) (Table 4). According to the averages of K rates, the highest root crude protein contents (14.37 and 13.82%) were obtained by application of K120 and K90, respectively.

The increased K doses caused increase in CP yields in the present study, because CP yield depends on DM yields in plots. Abdel-Gawad *et al.* 2008; Khan *et al.* 2009; Geweifel and Aly 1996; Karczmarczyk *et al.* 1995 reported crude protein content of fodder beet was significantly increased by increasing potassium fertilizer level.

Shoot crude protein content

Organic and potassium fertilization applications had significant effect on shoot CP content of fodder beet (Table 4). The K90 treatment resulted in the highest shoot CP content (8.43%) ($P \leq 0.05$), while O1 and O3 caused the highest CP shoot contents (8.32 and 8.37, respectively).

Table 4 The effect organic and potassium fertilizers on root and shoot dry matter (%), root and shoot crude protein contents (%) of fodder beet

Organic Fertilizer (O)	Potassium Fertilizer (P)	Root dry matter (%)	Shoot dry matter (%)	Crude protein in roots (%)	Crude protein in shoots (%)
Control (no addition) (O_1)	K90	10.00	1294	12.97	8.37
	K120	12.67	1372	13.90	8.37
	K160	11.33	1389	12.53	8.23
Mean		11.33 b	12.00 ab	13.13 b	8.32 a
Manure (O_2)	K90	11.67	12.33	14.13	8.03
	K120	10.33	10.69	13.57	7.63
	K160	11.00	11.33	11.33	6.83
Mean		11.00 b	11.44 b	13.01 b	7.50 b
Seaweeds extracts (O_3)	K90	14.00	15.00	14.37	8.90
	K120	12.33	11.33	15.63	8.27
	K160	13.00	13.00	13.97	7.93
Mean		13.11 a	13.11 a	14.66 a	8.37 a
Average of potassium	K90	11.89 a	12.78 a	13.82 a	8.43 a
	K120	11.78 a	11.67 a	14.37 a	8.09 b
	K160	11.78 a	12.11 a	12.61 b	7.67 c
Mean		11.81	12.19	13.60	8.06
LSD (O) 0.05		1.40*	1.62*	1.19*	0.42**
LSD (P) 0.05		0.71 ns	1.58 ns	0.84**	0.34**
LSD (O*P) 0.05		1.51*	2.50*	1.48 ns	0.57 ns
CV%		5.9	12.6	6.0	4.1

ns: not significant at 0.05 level of probability.

Conclusion

The highest ($p \leq 0.05$) production and quality traits were obtained with the addition of K90 and spray sea weed extracts.

References

Abdallah EF, Yassen AA. Fodder beet productivity under fertilization treatments and water augmentation. Australian Journal of Basic and Applied Sciences. 2008; 2(2): 282-287.

Abdel-Gwad MSA, El-Aziz TKA, El-Galil MAA. Effect of intercropping wheat with fodder beet under different levels of N-application on yield and quality. Annals of Agricultural Science (Cairo). 2008; 53 (2): 353- 362.

Abdel-Motagally A, Attia KK. Response of sugar beet plants to nitrogen and potassium fertilization in sandy calcareous soil. Int. J. Agric. Biol., 2009; 11(6): 695-700.

AL-Jbawi EM, Bagdadi M. Nemr Y. The effect of plant spacing on some quality traits of fodder beet (*Beta Vulgaris* var. *crassa*) varieties. International Journal of Environment. 2014; 3(3): 286-293.

Anonymous A. http:// www. Seed 2 grow. Co. UK/acatalogy/Fodder-Beet- seed.himl (2006).

Attia KK. Effect of saline irrigation water and foliar application with K, Zn and B on yield and quality of some sugar beet cultivars grown on a sandy loam calcareous soil. Workshop on "Agricultural Development in the Arab Nation, Obstacles and Solutions" January 20-22, 2004, Assiut, Egypt.

Bieniaszewski T, Fordonski G, Klupczynski Z. Effects of nitrogen and potassium fertilizer application on yield and feeding value of fodder beet cultivars. Acta Academic Agriculture Technical Olstenensis, Agriculture. 1995; 60: 73-84.

Chakwizira E, Fletcher AL, Meenken E, Johnstone P, Maley S, Arnold N, Armstrong S, George M, Sim RE, Minchin R, Morton JD, Stafford AD. Dry matter response of swede crops to phosphorus (P) and nitrogen (N) application in Southland and central North Island regions of New Zealand. Proceedings of the Agronomy Society of New Zealand. 2011; 41: 23-37.

Chakwizira E, Maley S, George M, Hubber R, Morton JD, Stafford AD. Effects of potassium, sodium and chloride fertilizer on fodder beet yield and mineral composition. In: Proceedings of the 5th Australasian Dairy Science Symposium. Ed. Jacobs, J. National Dairy Alliance, Melbourne, Australia. 2012; 431-434.

DAF (Department of Agriculture and Food). Root, fodder crop, pulse and oilseed varieties. Irish recommended list. Government Stationary Office, 1998; Dublin, 17 p.

Durand N, Briand X, Meyer C. The effect of marine bioactive substances (NPRO) and exogenous cytokinins on nitrate reduce activity in Arabidopsis thaliana. Physiol Plant. 2003; 119:489–493.

El Sarage E. Response of fodder beet cultivars to water stress and nitrogen fertilization in semi-arid regions. American Eurasian J. Agric. and Environ. Sci., 2013; 13 (9): 1168-1175.

El-Kholy MH, Abdelhamid MT, Selim EHH. Effect of soil salinity, nitrogen fertilization levels and potassium fertilization forms on growth, yield and quality of sugar beet crop in Eastnorthern Delta of Egypt. J. Agric. Sci. Mansoura University. 2006; 31: 4049-4063.

Geweifel HGM, Aly RM. Effect of nitrogen and potassium fertilization treatments on growth, yield and quality of some fodder beet varieties. Annals of Agricultural Science, Moshtohor. 1996; 34 (2): 441-454.

Gower S, Butler R, Armstrong SD. Yield comparisons of old and new cultivars of Swedes (*Brassica napus*ssp. *napobrassica*) in Southland, New Zealand. New Zealand Journal of Crop and Horticultural Science. 2006; 34, 109-114.

Ibrahim, YM. Ranges and forage. Dar Azza for publication, Khartoum, Sudan, 2005; 300p. (In Arabic)

Karczmarczyk S, Koszanski Z, Roy M, Sciazko D. Effect of sprinkler irrigation and nitrogen fertilizer application on sugar and fodder beets cultivated on a good rye complex soil. II. Chemical composition of the crop. Zeszyty Naukowe Akademii Rolniczej Szczecinie, Rolnictwo, 1995; 59: 65-72.

Khair MAM. Principles of forage production.1st edition. Publisher: Training and Publication Administration, Agricultural Research Corporation, Sudan, 1999; pp 219. (in Arabic)

Khan W, Rayirath UP, Subramanian S, Jithesh MN, Rayorath P, Hodges DM, Critchley AT, Craigie JS, Norrie J, Prithiviraj B. Seaweed extracts as biostimulants of plant growth and development. J. Plant Growth Regul., 2009; 28:386–399.

Kiely PO, Moloney AP, Meaghe, J. Ensiling and feeding whole-crop fodder beet. Landbau forchung-voelkerode Sonderheft, 1991; 123, 269-272.

Mancuso S, Azzarello E, Mugnai S, Briand X. Marine bioactive substances (IPA extract) improve ion fluxes and water stress tolerance in potted Vitis vinifera plants. Adv Hortic Sci., 2006; 20:156–161.

Marschner H. Mineral nutrition of higher plants. Academic press San Diego, USA. 1995.

Matthew C, Nelson NJ, Ferguson D, Xie Y. Fodder beet revisited. Proceedings of the Agronomy Society of New Zealand, 2011; 1995; 41: 39-48

Niazi BH, Rozema J, Broekman RA, Salim M. Dynamics of growth and water relations of fodder beet and sea beet in response to salinity. Journal of Agron. and Crop Sci., 2000; 184: 101-109.

Omar MA, Abd Allah MAA, Regab MM. Response of sugar beet to termination of last irrigation, hill spacing and K-fertilization. J. Agric. Sci. Mansoura Univ., 2002; 27: 4291-4302.

Ordog V, Stirk WA, Van Staden J, Novak O, Strnad M. Endogenous cytokinins in the three genera of microalgae from the Chlorophyta. J. Phycol., 2004; 40:88–95.

Pembleton K, Rawnsley R. Growing fodder beets on Tasmanian dairy farms. Tasmania Institute of Agriculture (TIAR). November 2011. http://www.utas.edu.au/__data/assets/pdf_file/0006/388113/Growing-fodder-beets-on-Tasmanian-dairy-farms.pdf.

Prokopenko LS, Olonicheva RV, Pidpalii IF. Amino acid composition and protein nutritive value of fodder beet. Visnik Agrarnoi Nauki, 1997; 1: 26-28.

Reddya AR, Chaitanya KV, Vivekanandanb M. Drought-induced responses of photosynthesis and antioxidant metabolism in higher plants. J. Plant Physiol., 2004; 161: 1189-1202.

Shalaby AS, Rammah AM, Abdul-Aziz GM, Beshay MG. Fodder beet, a new forage in Egypt. 1. Productivity and the chemical analysis of some Fodder beet (*Beta vulgaris* L.) cultivars sown at different locations in Egypt. In proceedings of the third Egyptian British Conference on Animals, fish and poultry production. Alexandria, Egypt, 13: 133-143. [C.F. Nadaf, S.K., Ibrhaim, Y.M., Akhtar, M., El Hag, M.G. and Al-Lawati, A.H., (1998a). Performance of Fodder beet in Oman. Annals of Arid Zone, 1989; 37 (4): 377-382.

Šrek P, Hejcman M, Kunzová E. Multivariate analysis of relationship between potato (*Solanum tuberosum* L.) yield, amount of applied elements, their concentrations in tubers and uptake in a long-term fertilizer experiment Original Research Article. Field Crops Research, 2010; 118(2): 183-193.

Stirk WA, Novak MS, Van Staden J. Cytokinins in macroalgae. Plant Growth Regul., 2003; 41:13–24.

Turk M. Effects of fertilization on root yield and quality of fodder beet (*Beta Vulgaris* Var. Crassa Mansf.). Bulgarian Journal of Agricultural Science. 2012; 16 (2): 212-219.

Wilson DR, Reid JB, Zyskowski RF, Maley S, Pearson AJ, Armstrong SD, Catto WD, Stafford AD. Forecasting fertilizer requirements of forage brassica crops. Proceedings of the New Zealand Grassland Association. 2006; 68: 205-210.