Prospects of Sugarbeet Production in the Sudan

Mohammed O. El-Karouri and Ahmed El-Rayah [1]

Summary

Sugarbeet (*Beta vulgaris*) is a member of the family *Chenopodiaceae*. It is mainly a crop of temperate regions where it is grown as a spring or early summer crop. It ranks second to sugar cane as a source of sucrose in the world. Scientific research on sugarbeet, in the Sudan dates back to 1930s where it was investigated among other crops as a substitute for cotton in the Gezira Scheme. The results of the experiments were not encouraging because of the low yield of the tested cultivars which was in the range of 9.5-17.9 t/ha. Being discouraged by the low yields and the low sucrose content, no further work on the crop had been pursued since then.

In 1994/95 winter season however the Arab Authority for Agricultural Investment & Development (AAAID) subjected the crop to further investigations on the assumption that the crop may prove its worth further north. Thus an experiment to evaluate the performance of 14 genotypes was carried out at AAAID farm at Um Dom near Khartoum during 1994/95-1996/97 seasons. The site is characterized by relatively cool winters, hot summers and low relative humidity. The soils are classified as Aridisols containing varying amounts of Salt and Sodium which constitute the main limitation for crop production.

The crop was sown in the second week of October and harvested in the second week of April. When the yield was averaged across the three seasons, it was in the range of 85.9-81.0t/ha. This yield is considered high compared to international average or even to that of high yielding beet producing countries. The sucrose content on the other hand was in the range of 12%-15.7% which is comparable to that of Arab countries but lower than that of some European countries where up to 20% sucrose content is achievable. However sucrose production/unit area which was in the range of 7.5-12.0 t/ha is higher than that of many beet producing countries.

The results indicate that sugarbeet could be considered a potential winter crop in Sudan particularly in the North. Further trials are required to identify agronomic practices that improve the quality of the crop.

Keywords: Sugarbeet; AAAID; Um Dom.

Introduction

Sugarbeet (*Beta vulgaris*), is a member of the family *Chenopodiaceae*. It is characterized by green and veined leaves and a large taperoot which gradually tapers into a relatively small root. The mature beet, an elongated pear-shaped body, is composed of three regions namely, the crown, the neck and the root (Fig.1). The crown is the broadened somewhat cone-shaped apex that bears a tuft of succulent leaves and leaf bases. The leaves are arranged on the crown in a close spiral. Below the crown is the neck, which is the broadest part of the beet. Just below it is the cone-shaped root, terminating into a slender taproot. The root is flattened on two sides with a groove. The cone-shaped roots range in weight from 0.5kg up to 3 kg, depending on stand, soil moisture, climatic conditions, pests and diseases and other factors (Kipps, 1981).

Sugarbeet is a crop of temperate regions as a summer crop but proved its success in sub-tropical areas as a winter crop. It ranks second to sugar cane as the two most important sugar crops in the world. According to production statistics (FAO Production Yearbook, 1997) total world production of sugarbeet is 266 million tons from a production area of 7.8 million hectares. The former USSR is the leading producer of sugar beet accounting for 20% of the world s production followed by France , Germany and Italy.

In the Arab region the area under sugarbeet is 114000 hectars with a total production of 5.3 million tons. The leading beet producing Arab country is Morocco which produces about 49% of the total production of all Arab countries. In Egypt, however although the crop was intro-

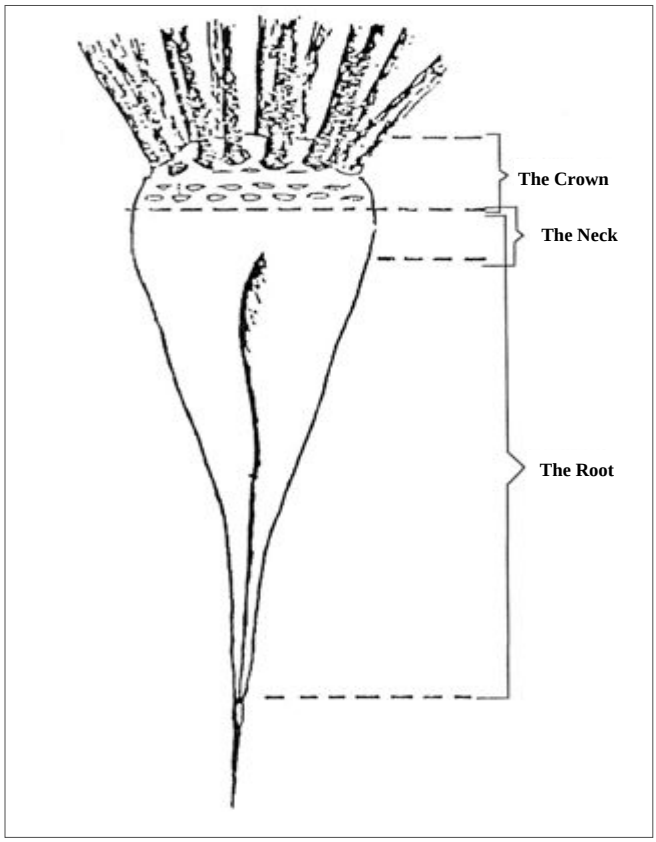

Fig. 1. Mature sugar beet roots.

[1] **Arab Authority for Agricultural Investment and Development (AAAID), P.O. Box 2102 Khartoum, Sudan, Fax: (+249) 183 772600, E-mail: aelrayah@aaaid.org**

duced on a commercial scale fifteen years ago, its cultivation is expanding less rapidly. Being a more efficient user of water, the government policy now is discouraging further expansion in cane area, indeed, if possible to substitute beet for cane even in the warmer conditions of southern Egypt (Afifi, 1996).

Sudan has no experience in beet production although scientific research on the crop had started nearly seventy years ago. The first trials recorded were carried out at Gezira Research Farm (GRF) during the depression of the 1930s, when a substitute for cotton was being actively sought. It was considered at that time as a possible source of sugar during the war.

A number of cultivars from different sources were tested. The results of the experiments indicated that the general level of yields was quite low ranging from 9.5 to 17.85 mt/ha. In fertilizer experiments the best responses were to N + P, second to P, third to N and none to K. Being discouraged by the low yields and the low sugar content the trials were not seriously followed up and no further work on the crop has been pursued since then (Agric. Res. Report, 1953).

In 1994/95 season the Arab Authority for Agricultural Investment and Development (AAAID) revived experimental work on sugar beet based on its reckoning that the crop did not receive due attention in the past and that it should not be condemned or judged by the outcome of earlier experiments which were sporadic, inconclusive and were carried out in the Gezira scheme which has a warm climate. Moreover, although it is a sound principle to grow crops which are considered to be ecologically suited to the region, it is equally a sound principle to give all possible crops a trial and not to condemn them till it is certain they have failed for fundamental reasons.

Thus by subjecting the crop for more investigations further north as a winter crop where the climate is sufficiently mild and where weather conditions during winter are comparable to some parts of the world where beet is grown as a summer crop as in Southern California for example, beet culture may prove to be a successful venture in northern Sudan. The following experiments have therefore been carried out to test the validity of such hypotheses.

Materials and Methods

The experiments were carried out at Um Dom farm which lies in the east bank of the Blue Nile about 20km from Khartoum at latitude 15^{o} 40N and longitude 32^{o} 32*E*. The site of the experiments lies in an arid semi-desert continental climatic zone characterized by relatively cool winters, hot summers, low rainfall, low relative humidity and a potential evapotanspiration which exceeds precipitation throughout the year.

The soils of the farm are classified as Aridisols, soils of arid and hot areas. They are presumably deposited by the Blue Nile, containing varying amounts of salts(EC:2-6 mmhos/cm) and exchangeable sodium (ESP:8-18) which constitute the main limitations for crop production. Organic matter is generally low, total nitrogen is in the order of 0.03% to 0.06% and available phosphorus is in the range of 50-180ppm. For more detailed information on climate, soils and irrigation of the experimental site refer to Ibrahim and Karouri (1984) and Scet Int. (1980).

The experimental design was a randomized complete block having three replications with plot size measurements of 7mx6m, the treatments were 14 genotypes requested from sugarbeet companies. The same genotypes were tested for three consecutive seasons from 1994/95-1995/96-1996/97.

The following are the genotypes (treatments) which were tested:

1. Gala.
2. Sonja M.
3. Ramela.
4. Kaweterma.
5. HH.41 No. M LT 412311.
6. HH.96 No. L LT 463002.
7. HH-38 No. S LT 381005.
8. USC-4 LT 043303.
9. HH-39 No. M LT 392006.
10. HH-52 No. SLT 52102.
11. HH-39 No. MLT 39220.
12. HH-39 No. MLT 392301.
13. HH-79 PC LT 793408.
14. HH-37 No. 5 LT 371312

The sugarbeet was established with furrow irrigation on single row planting system. Seedbed was prepared using the appropriate field machinery, Only nitrogen fertilizer was added at the rate of 49kg N/ha in the form of urea as a preplant followed by a second dose of the same rate six weeks after emergence. Seeds were sown on the second week of October at the rate of two seeds/hole and a distance of 15cm between holes. Seeds were planted on top of the shoulder of the ridge in rows 80 cm apart. Four weeks after emergence the stand was hand-thinned to one plant per hole to giving an average plant density of 80000 plants/ha.

Since the crop does not tolerate drought the frequency of irrigation was at 8-10 days interval, enough to prevent plant water stress. Weeds were controlled by hand when necessary.

The plots were harvested in the second week of April when the plants showed signs of maturity which is indicated by leaf yellowing and partial drying of the lower leaves. Elsewhere, for certain economic considerations such as lengthening the working days of the sugar factory the crop could be harvested earlier (Lauer, 1997). Harvesting is done by pulling the beet manually, and topped by cutting the crown at the base of the leaves. The topped beets were weighed for yield measurements and samples were taken for the determination of sugar content using the Pol method (Payne, 1968).

Results and Discussion

Yield results are shown in Table (1). Average yields of the three seasons was in the range of 71.5-81 tons/ha. The

results indicate a very high yield potential compared to yields attained in beet producing countries, where the international average yield was 34.2 tons/ha and the highest European yield (France) was 72 tons/ha, while the average yield of beet producing Arab countries was 44.2 tons/ha (FAO production Yearbook 1997). The very high yields obtained are a positive indication of the adaptability of sugar beet, as far as yield is concerned, to the region of the experimental site. However the high yield shown by all genotypes tested may be attributed to the favourable growing conditions for the crop, where the high expansion of the foliage and hence an accelerated rate of growth were responsible for the large yield potential. This contrasts with the conditions in cold climates where the potential yield is smaller because canopy expansion takes longer in the prevailing cool spring and early summer which is the growing season in Europe where most of the sugar beet is produced. Incidentally beet size of some of the plants in these experiments particularly those of the outer rows (edge effect) was over 12kg, a reflection of the potential for higher yields.

Table 1. Beet yield (tons/ha)

Genotype No.	Seasons			Average yield *
	1994/95	1995/96	1996/97	
1. Gala	78.0	85.0	80.2	81.0
2. Sonja M	83.9	79.2	59.8	77.6
3. Ramela	86.3	86.6	85.8	80.2
4. Kaweterma	66.7	60.8	69.4	72.1
5. HH-41 No.M LT 412311	73.3	78.3	85.6	79.1
6. HH-96 No.L LT 463002	76.7	74.9	80.2	77.2
7. HH-38 No.S LT 381005	77.7	73.3	73.3	74.8
8. USC-4 LT 043303	77.5	78.3	82.9	79.6
9. HH-39 No.M LT 392006	82.9	72.9	74.6	76.8
10.HH-52 No.S LT 52102	87.1	77.0	73.3	79.1
11.HH-39 No.M LT 39220	82.0	68.7	63.9	71.5
12.HH-39 No.M LT 392301	84.2	76.7	67.6	76.2
13.HH-79 PC LT 793408	90.4	77.9	69.6	79.3
14-HH-37 No.5 LT 371312	31.0	75.0	70.6	75.5
Mean	76.9	76.0	74.1	75.7

* tons/ha.

As shown in Table (2) the sugar content of most of the genotypes was not high, but some of the genotypes gave satisfactory levels of sugar content comparable to that of beet producing countries which is in the range of 15-20% (Martin *et al.*, 1967) while in Arab countries it ranged from 10-15%. (Afifi, 1996). Sugar production per unit area for the different genotypes ranged from 9.5-12.1 tons/ha (Table 3). This compares very well with that of beet producing countries (FAO Production Yearbook, 1997).

Unlike the results of the 1930s trials, the results of these trials are very encouraging, indicative of the potential success of sugar beet as a winter crop in Northern Sudan. However because of relatively cooler and longer winter season the crop may be more adaptable further north where the climatic conditions during the growing season (Nov./ March) are within the tolerable range for beet production.

Table 2. Sucrose content (%) for 1994/95 and 1995/96 seasons

Genotype No.	Seasons		Average
	1994/95	1995/96	
1. Gala	13.0	15.1	14.1
2. Sonja M	15.8	15.5	15.7
3. Ramela	12.6	14.3	13.5
4. Kaweterma	16.1	13.2	14.7
5. HH-41 No.M LT 412311	14.9	12.6	13.8
6. HH-96 No.L LT 463002	12.2	12.9	12.6
7. HH-38 No.S LT 381005	15.4	13.1	14.3
8. USC-4 LT 043303	12.6	12.7	14.3
9. HH-39 No.M LT 392006	14.3	12.8	13.6
10.HH-52 No.S LT 52102	11.4	12.6	12.0
11.HH-39 No.M LT 39220	12.9	16.0	14.5
12.HH-39 No.M LT 392301	13.3	13.0	13.2
13.HH-79 PC LT 793408	13.3	11.4	12.4
14-HH-37 No.5 LT 371312	14.3	14.2	14.3
Mean	13.7	13.5	13.6

Table 3. Average sucrose yield/ha (1994/95 and 1995/96 seasons)

Genotype	Seasons		Average yield *
	1994/95	1995/96	
1. Gala	10.40	12.84	11.62
2. Sonja M	13.20	12.28	12.74
3. Ramela	10.87	12.38	11.63
4. Kaweterma	10.74	8.02	9.38
5. HH-41 No.M LT 412311	10/92	9.87	10.40
6. HH-96 No.L LT 463002	9/35	9.66	9.51
7. HH-38 No.S LT 381005	11.94	9.60	10.77
8. USC-4 LT 043303	9.76	9.94	9.85
9. HH-39 No.M LT 392006	11.89	9.33	10.59
10.HH-52 No.S LT 52102	9.93	9.70	9.82
11.HH-39 No.M LT 39220	10.58	10.99	10.78
12.HH-39 No.M LT 392301	11.20	9.97	10.59
13.HH-79 PC LT 793408	12.02	8.89	10.46
14-HH-37 No.5 LT 371312	4.43	10.65	7.54
Mean	10.51	19.29	10.40

* tons/ha.

During this period the average temperature in northern Sudan is within the optimum range for root development of 24^{o}C and below the retarding sugar accumulating temperature of 30^{o}C (Kipps, 1981) while the drop in temperature in December-January period is conducive to raising the sugar content of the beet. Moreover the climate of northern Sudan during the winter is comparable to the summer temperature in Southern California where beet culture is quite successful. This may lend a supporting evidence to the possible success of beet culture in the northern parts of the Sudan.

Sugar beet like most of the members of the family *Chenopodiaceae* is a salt tolerant plant (Richards, 1954) and in this respect may be a suitable crop for northern Sudan particularly in the dominantly light-textured salt affected high terrace soils which constitute a large proportion of the undeveloped lands on which the two Wilayas of the north

will depend to a large extent for their future agricultural development (El-Karouri and Mansi, 1981). Being an easy rotational crop where farmers can dispose off by the end of the winter season, the inclusion of sugar beet in the rotation facilitates crop diversification and could lead to the spread of small factories for sugar extraction at the village level (cottage industry). Thus besides providing self-sufficiency in sugar commodity it will add an extra income to small farmers. Moreover, the by-products of beet culture and manufacturing industry are an excellent feed for animals.

Besides the climatic factors, agronomic factors can influence the performance and success of beet culture. Hence a series of experiments are being pursued at AAAID farms to identify agronomic practices e.g., sowing date, fertilization, harvesting date .etc, that improve the yield and quality of the crop.

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آفاق زراعة بنجر السكر في السودان

مُحمَّد عُثمان الكاروري و أحمد الريح[1]

الخلاصة

ينتمي البنجر السُكَّري إلى العائلة المرمرية وهو من محاصيل المناطق المُعتدلة حيث تتم زراعته خلال فصل الرَّبيع أو أوائل موسم الصيف. ويحتلُّ بنجر السُكَّر المرتبة الثانية بعد قصب السُكَّر كمصدرٍ لإنتاج السُكَّروز على مُستوى العالم.

لقد تمَّت تجربة زراعة بنجر السُكَّر في السودان لأوَّل مرة خلال الثلاثينات من القرن الماضي. وكان الهدف من تجربة زراعته آنذاك هو إيجاد بديل لمحصول القطن الذي كان يُزرع وما زال في مشروع الجزيرة. ولكن لم يتحقَّق الهدف بسبب ضعف الإنتاجية التي تراوحت مابين 9.5–11.9% طن للهكتار. إضافةً إلى تدنِّي مُحتوى نسبة السُكَّروز في المحصول. وعليه فمنذ ذلك التاريخ توقَّفت تجارب ومحاولة إدخال بنجر السُكَّر كمحصولٍ زراعي في السودان.

بافتراض أنَّ زراعة محصول بنجر السُكَّر رُبَّما تنجح شمالاً فقد قامت وحدة التجارُب الحقلية بالهيئة العربية للاستثمار والإنماء الزراعي بتجربة زراعة هذا المحصول خلال مواسم شتاء (1994/1995–1996/1997) في مزرعة أم دوم التابعة للهيئة. وتتميَّز منطقة أم دوم بشتاء بارد نسبياً وصيف حار ودرجة مُنخفضة من الرطوبة النسبية. أما تُربتها فتنتمي إلى تربة Aridisols وهي تحتوي على نسبٍ مُتفاوتة من الملوحة والقلوية والتي رُبَّما تكون الأكثر أثراً على نمو وإنتاجية المحصول.

خلال الثلاث مواسم تمَّت تجربة 14 صنفاً تم استيرادها من مصادر مُختلفة. تتم عادةً زراعة المحصول خلال الأُسبوع الثاني من أكتوبر ويتم حصاده في الأُسبوع الثاني من أبريل. تراوحت الإنتاجية ما بين 81 إلى 85.9 طن للهكتار. وتُعتبر هذه الإنتاجية عالية بكل المقاييس مُقارنةً بمُتوسِّط الإنتاجية في البلاد الرئيسية المُنتجة للمحصول. أمَّا نسبة السُكَّروز فتراوحت ما بين 12.4 إلى 15.7%وهي نسبة أقلَّ من معدلات البلاد الأوربية والتي قد تصل فيها نسبة السكر إلى أكثر من 20% ولكنها في حدود مُعدَّلات الدول العربية المنتجة للبنجر . أمَّا الإنتاج الكلي للسُكَّروز في وحدة المساحة فقد تراوحت ما بين 7.5 إلى 12.0 طن للهكتار وهذه مُعدَّلات مُرتفعة مُقارنةً بالمُعدَّلات العالمية.

خلاصة القول واستناداً على مُعطيات هذه التجارُب هنالك مجال لزراعة بنجر السُكَّر كمحصولٍ شتوي في السودان، خاصَّة في المناطق الشمالية. إلا أنَّ الأمر يحتاجُ إلى إجراء المزيد من التجارُب والدراسات لتحديد أفضل المُعاملات الفلاحية والمُدخلات الإنتاجية المُناسبة لتجويد الإنتاج .

[1] الهيئة العربية للاستثمار والإنماء الزراعي، ص.ب. 2102 الخرطوم، السودان، فاكس: 772600 183 (+249)، بريد إلكتروني: aelrayah@aaaid.org