FOLIAR TREATMENTS RESPONSE OF SUGAR BEET (BETA VULGARIS L.)

Ungai Diána [*], Győri Z. [*]

[*] University of Debrecen, Centre of Agricultural Sciences, Department of Food Science and Quality Assurance

Abstract

The aim of sugar beet processors world-wide is to produce pure sugar, at least expense, from the roots which they have purchased and which represent their major manufacturing cost. Although the efficiency of processing depends to a large extent on the factory equipment and the way in which it is utilised, it is the quality of the roots which is by far the most important parameter affecting processing (Cooke and Scott, 1993).

Sugar beet has an outstanding place among the plants, rentability of sugar manufacture is determined by the stability of yield and the quality (saccharose content) of sugar beet. The most important constituent of beet is certainly sucrose, while the various non-sucrose substances impair the sugar yield to different degrees. The yield and the quality of the sugar beet are mainly determined by the plant production system, so we studied the effect of different foliar treatments. Our field trials were carried out in Hajdúböszörmény at two sites. Plot size was 24 m × 300 m. In our experiment we examined the effect of sulphur (Cosavet DF, 5 kg ha^{-1}), copper (Kelcare Cu, 0,5 kg ha^{-1}) and two foliar fertilizers(these were Biomit plussz, 4 l ha^{-1}; and Fitohorm Euro Öko Gyökérgumós, 4 l ha^{-1}) with organic and inorganic active agents.

We have found that the crop- and the sugar yield were significantly influenced by the foliar treatments. It can be stated that fertilization increased the crop yield, while the quality parameters (as above) have not changed. This way the sugar yield significantly increased on the effect of different foliar fertilizers.

Key words: sugar beet, foliar treatment, sugar yield

INTRODUCTION

The molassigenic substances such as potassium, sodium, raffinose and N compounds such as amino-N and betaine increase the molasses loss, whereas invert sugar and glutamine lead to colour formation during evaporation and crystallisation as a consequence of the Maillard reaction. This is regarded as a major quality impairing factor for white sugar (VAN DER POEL et al., 1998).

In common with most crops, climate and soils are the two main determinants of yield per unit area. Both are outside the growers' control but next most important is the plant's nutrition, which can be manipulated to the advantage of producer and processor (DRAYCOTT and CHRISTENSON, 2003).

Fertilisation of sugar beet requires special knowledge. An adequate nutrient supply is one of the important factors for both yield and quality of sugar beet (KULCSÁR and JÁSZBERÉNYI, 1999). The effect of unfavourable soil conditions on yield and quality can be decreased by foliar

fertilization and plant nutrition. This way, the yield stability of sugar beet producing on Hungarian Plains can be improved (RUZSÁNYI et al., 2001).
Sulphur deficiency has been recognized as a constraint to agricultural production, since it has been shown not only to influence yield, but also the quality of many crops, such as oil seed rape (FISMES et al., 2000; MCGRATH and ZHAO, 1996) and cereals (HANEKLAUS et al., 1995; SYERS and CURTIN, 1987) as well as grassland (SCOTT et al., 1983; SYERS and CURTIN, 1987). Sulphur is one of the major nutrients and is required to synthesize key amino acids, which in turn are needed to produce functional and structural proteins (WILLENBRINK, 1967). In future, fertilizer sulphur may well be needed. An alternative, being used on other crops, is also elemental sulphur. New experiments are needed now to establish the need for sulphur (DRAYCOTT and CHRISTENSON, 2003).

In addition to the major nutrient elements, sugar beet, in common with other crops, needs very small amounts of other elements. Localised areas may show sporadic symptoms and some crops may be short of copper but this deficience appear, at present, to be of little economic significance. However, as yields continue to increase and farming practices change, application of this micronutrient may become more important (COOKE and SCOTT, 1993). The sugar beet is moderately responsive to copper. Occasionally copper deficiency may be found, but this micronutrient deficience is generally corrected with fertilizer materials applied either to soil or to plant foliage (DRAYCOTT and CHRISTENSON, 2003).

In our experiment we examined the effect of sulphur, copper and two foliar fertilizers with organic and inorganic active agents.

METHODS

Our plot experiment in randomised blocks in four replications was set up in Hajdúböszörmény (N 47˚41' E 21˚30' ; elev above 368 ft) in 2005 at two sites (Béke Agricultural Cooperative – 1st site and Hajdúböszörményi Agricultural Plc. – 2nd site) on chernozem soil. The soil is suitable for the sugar beet cultivation at both of the sites.
Plot size was 24 m × 300 m.

The studied variety was Picasso on the 1st site and Liana on the 2nd site. The fore crop was winter wheat at both of the sites.

We examined the response of sugar beet to sulphur (Cosavet DF, 5 kg ha^{-1}), copper (Kelcare Cu, 0,5 kg ha^{-1}) and two foliar nutrients with high active agent (these were Biomit plussz, 4 l ha^{-1}; and Fitohorm Euro Öko Gyökérgumós, 4 l ha^{-1}) sprayed with 200 l ha^{-1} water at both of the sites.
The treatments and dates are in *Table 1*.

Table 1

Treatments and application dates

Treatments	1st application	2nd application	3rd application
	31.05.2005 03.06.2005	**21.06.2005 27.06.2005.**	**01.08.2005 31.08.2005**
1. Control	-	-	-
2. Biomit Plussz	+	+	+
3.Fitohorm Euro Gyökérgumós	-	+	+
4. Cosavet DF	-	+	-
5. Kelcare Cu	-	+	-
6. Cosavet Df + Kelcare Cu	-	+	-

Produced by: Biomit Ltd. Hungary(2); Fitohorm Ltd. Hungary (3); Sulphur Mills (4); Kemira GrowHow Hungary (5).

We have taken root- and leaf samples at 4 week intervals, starting at the beginning of July. The harvest of sugar beet was on November. We determined the weight of root in the field. The quality parameters (sucrose, potassium, sodium and alfa-amino N content) of the root samples was determined from filtrated beet brei, by an automatic beet laboratory system, called VENEMA in the Kabai Eastern Sugar Plc. Hungary. Sucrose was analysed polarimetrically, potassium and sodium were determined by flame-photometry and alpha-amino nitrogen was analysed by the fluorometric method. The white sugar yield was calculated from beet yield, sucrose concentration and standard molasses loss.
The results of the experiment were processed SPSS 12.0 for Windows.

RESULTS AND DISCUSSIONS

At row closing we removed 40 fully expanded leaves from each plot according to the literature' documentation. After we collected these samples from the field, we returned to the laboratory. Samples were dried in an oven at 60 ˚C for 5 days, to obtain dry weights. Macro and micro element content were determined by ICP-OES. We come to the conclusion that the average of the six treatments we measured similar values, than the Plant nutrition Institute Jena (ELEK and KÁDÁR, 1980). The results are in the table 2.

Table 2

Results of the leaf-samples analysis

Elements	Adequacy quantity (Plant nutrition Institute Jena)	Average of the treatments (1^{st} site)	Average of the treatments (2^{nd} site)
N %	3,6-4,0	4,19	4,03
P %	0,31-0,60	0,34	0,39
K %	2,0-6,0	2,68	2,43
Ca %	0,50-1,50	0,81	0,79
Mg %	0,25-1,0	0,59	0,75
SO4-S %	0,05-1,4	0,56	0,55
Mn ppm	26-360	274,15	147,25
Zn ppm	10-80	32,10	39,88
Cu ppm	9-13	14,96	18,35
B ppm	31-200	52,64	42,95
Mo ppm	0,20-2,00	1,98	1,84

Samples: Fully expanded leaves, without leaf-stalk

We measured the highest yield in the second treatment (75,15 and 90,74 t ha^{-1}), and the lowest on the control plots (65,12 and 74,65 t ha^{-1}) at both of the sites (*Figure 1.*). There were significant differences between the foliar treatments.

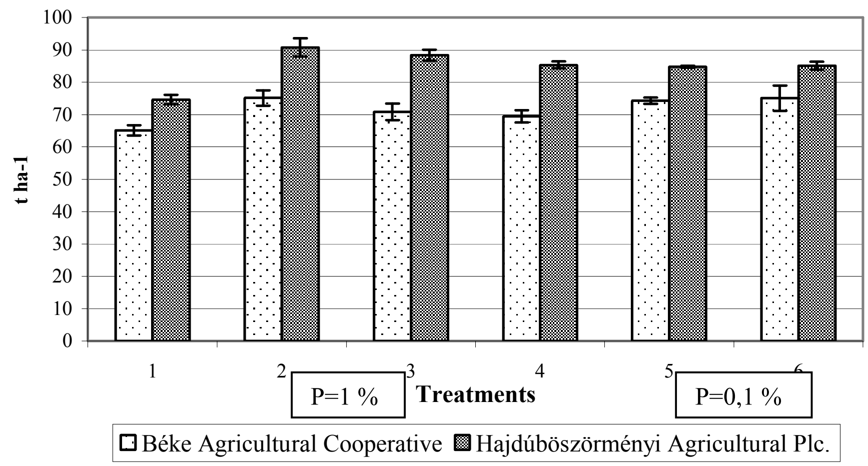

Figure 1. Root yield in the different treatments in 2005

In the average of 6 treatments the sugar content was 14,66 % on the 1^{st} and 14,23 % on the 2^{nd} site, however there were no significant differences between the results of treatments. Similar result was observed in the case of sodium, potassium and alpha amino-content. There were not found significant difference between the treatments.

The highest sugar yield was obtained on plots treated with Cosavet DF (Figure 2.). On the 1st site we measured the highest net sugar yield on plots treated with Cosavet DF (9,62 t ha^{-1}), and on the 2nd site Cosavet DF, combined with Kelcare Cu (11,70 t ha^{-1}).

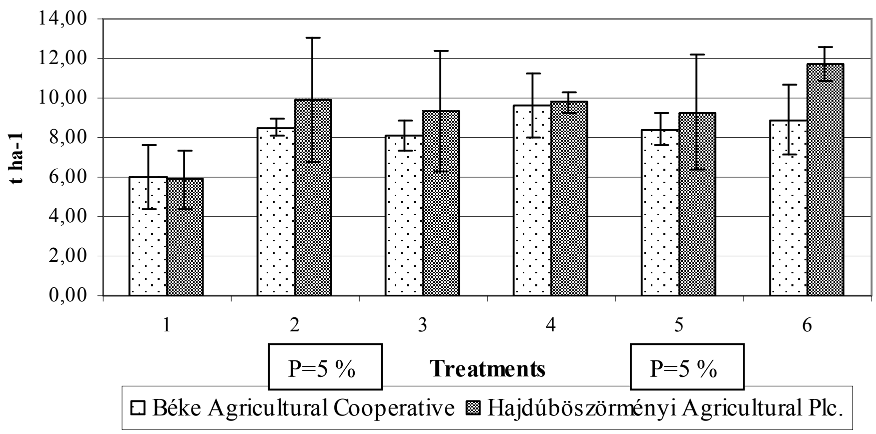

Figure 2. Net sugar yield in the different treatments in 2005

CONCLUSIONS

We have found that the crop- and the sugar yield were significantly influenced by the foliar treatments. It can be stated that fertilization increased the crop yield, while the quality parameters (as above) have not changed. This way the sugar yield significantly increased on the effect of different foliar fertilizers.

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REFERENCES

1. A. Philip Draycott – Donald R. Christenson, 2003, Nutrients for sugar beet production. Soil-Plant Relationships. CABI Publishing. Wallingford.
2. D. A. Cooke – R. K. Scott (ed.), 1993, The Sugar Beet Crop. Science into practice. Chapman&Hall. London 571-619.
3. Elek É. – Kádár I., 1980, Állókultúrák és szántóföldi növények mintavételi módszere. MÉM NAK. Budapest.

4. Fismes, J.- Vong, P. C.- Guckert, A.- Frossard, E., 2000, Influence of sulfur on apparent N-use efficiency, yield and quality of oil seed rape(Brassica napus L.) grown on a calcareous soil. Eur. J. Agron. 12, pp. 127-141.
5. Haneklaus, S. – Fleckenstein, J. – Schnug, E., 1995, Comparative studies of plant and soil analysis for the sulphur status of oil seed rape and winter wheat. Z. Pflanzenernähr. Bodenkde. 158, pp. 109-111.
6. L. Kulcsár – I. Jászberényi, 1999, Nutrient management and advisory systems for sugar beet in Hungary. Balanced plant nutrition in sugar beet cropping systems for high yield and quality. (ed.: I. Buzás and A. 7. E. Johnston). Proceedings of the Regional Workshop of Beta Research Institute – IMPHOS – IPI. 185-193. p.
8. McGrath, S. P. – Zhao, F. J., 1996, Sulphur uptake, yield responses and the interactions between nitrogen and sulphur in winter oil seed rape (Brassica napus). J. Agric. Sci. (Cambridge) 126, pp. 53-62.
9. P. W. Van de Poel – H. Schiweck – T. Schwartz, 1998, Sugar technology. Beet and Cane Sugar Manufacture. Albert Bartens KG. Berlin.
10. Ruzsányi L. – Lesznyák Mné. – Varga L., 2001, A termőtáj, a tenyészidő és a cukorrépa minősége közötti összefüggések. Proceedings. Budapest. II. Növénytermesztési Tudományos Nap. 205. p.
11. Scott, N. M. – Watson, M. E. – Caldwell, K. S. – Inkson, R. H. E., 1983, Response of grassland to the application of sulphur at two sites in north-east Scotland. J. Sci. Food Agric. 34, pp. 357-361.
12. Syers, J. K. – Curtin, D., 1987, Soil and Fertiliser Sulphur in UK Agriculture. The Fertiliser Society, London, pp. 1-43.
13. Willenbrink, J., 1967, Über Beziehungen zwischen Proteinumsatz und Schwefelversorgung der Chloroplasten. Z. Pflanzenphysiol. 56, pp. 427-438.