Institute of Sugar Beet Research
GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN
Christian-Albrechts-University of Kiel
Institute of Agricultural Engineering

Producing biogas from winter beet: Is it reasonable?

Nicol Stockfisch[1] & Susanne Ohl[2]

Introduction

- In Germany, the increasing biogas production intensifies the focus on the type of cultivated bioenergy crops. Winter beet could broaden the crop diversity and – at the same time – increase the methane yield per hectare.
- Energy crops have to be preserved to ensure a year-round feeding of biogas plants. The ensiling leads both to a loss of dry matter and a change in the composition of substrate.

Objectives

- To develop and evaluate a draft of a cultivation system for winter beet;
- To quantify the dry matter losses of lab-scale silages;
- To determine the specific methane production of silage.

Fig. 1: Winter beet in February and June

Materials and Methods

- Cultivation intensity in field trials was rather high in order to allow for optimum plant development and to attain maximum yield. The drafts of the cultivation systems were adopted based on experience.
- 3 genotypes of winter beet (sowing in August) and conventional sugar beets were cultivated in the field.
- Samples of whole bolted beets and sugar beets were taken in June or November, respectively, and either chopped to pulp, crumbled (<5 cm) or unground ensiled in film bags. Silages were opened after 90 days, then pH, dry matter, organic dry matter and fermentation acids were determined.
- Fermentation tests (Fig.2) were carried out in compliance with German Standard Procedure VDI 4630 (2006) for 21 days at 38°C, specific biogas- and methane production were determined.

Fig. 2: Batch fermentation test

Results

- The timing of cultivation measures differed between the cultivation systems. This might interfere with field work for other crops in a commercial farm.
- Diesel consumption was lower for winter beet than for spring-sown sugar beet. If this result can be confirmed by further investigations, it would be advantageous to cultivate winter beet for biogas production.
- Optimum cultivation intensity was not tested, so the presumed cultivation system might be different from an optimized management system for winter beet in the field.
- Depending on the treatment, different fermentation profiles and dry matter losses between 5 to 38% were observed despite ideal laboratory conditions. A lot of silage effluent was produced during the ensiling of sugar and winter beets, which increases the losses if the effluent is not supplied to the biogas process.
- The specific methane production (Fig. 3) of sugar beets is higher (373 l_N/kg_{oDM}) than that of winter beets (beet: 360 l_N/kg_{oDM}, whole bolted plant: 331 l_N/kg_{oDM}). The difference in methane yield per hectare is even larger due to the differences in dry matter yield.

Tab. 1: Comparison of proposed cultivation systems

measures		intensity		diesel consumption* (MJ ha^{-1})	
		sugar beet	winter beet	sugar beet	winter beet
stubble cultivation	1st passage	5cm working depth	5cm working depth	233	233
fertilisation	application of P_2O_5, K_2O, CaO	according to nutrient uptake of the plants	according to nutrient uptake of the plants	29	35
stubble cultivation	2nd passage	15 cm working depth	15 cm working depth	271	271
catch crop	sowing mustard	in Aug.: 20 kg ha^{-1}	–	159	–
	N application	40 kg N ha^{-1}	–	38	–
	mulching	in Oct./Nov.	–	284	–
seedbed preparation	harrowing	3 cm working depth	3 cm working depth	143	143
sowing	drilling to stand	in April, distance 20 cm	in Aug., distance 15 cm	120	120
fertilisation	N application	110 kg N ha^{-1}	40 + 70 kg N ha^{-1}	38	76
pesticides	herbicides	3 x dicotyledons	3 x dicotyledons 2 x monocotyledons	118	197
	fungicides	1 x leaf spot diseases	1-2 x leaf spot diseases, fungal infection of leaves	39	79
	insecticides	-	1 x aphids	–	39
harvest		in Oct.: self-propelled beet harvester	in June: harvesting technique not specified/ to be developed	1989	*1655*
			total diesel consumed for machinery	3,5 GJ ha^{-1} = 100 %	2,9 GJ ha^{-1} = 82 %

*according to KTBL

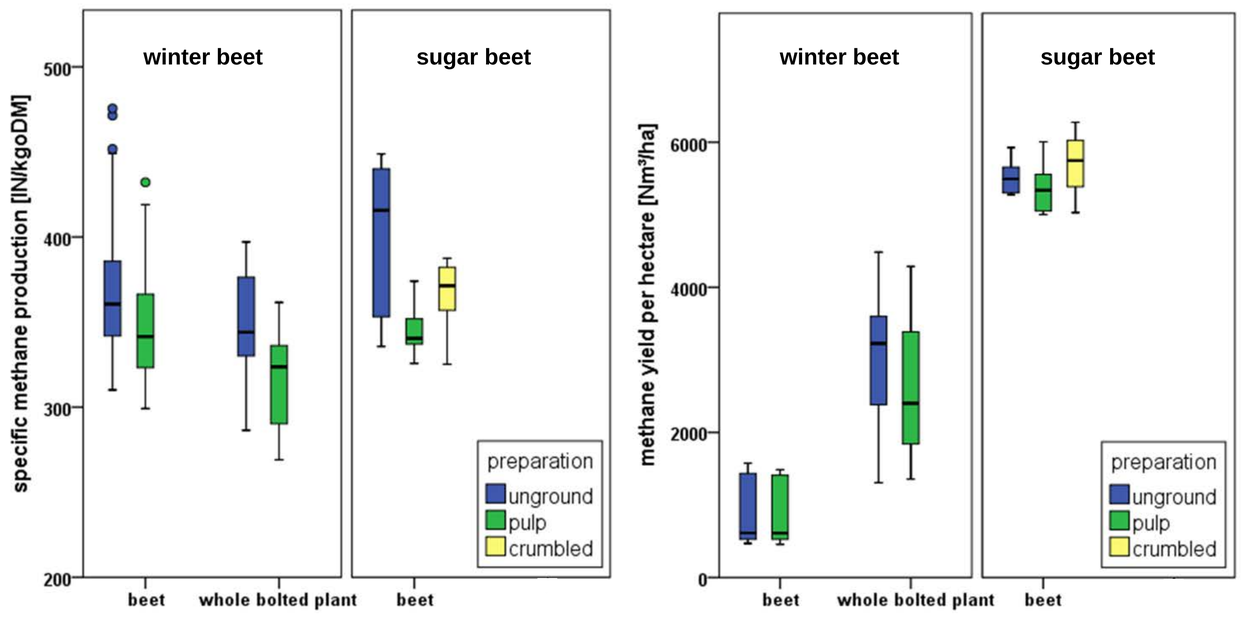

Fig. 3: Specific methane production and methane yield per hectare of ensiled winter beet and conventionally grown sugar beet

Conclusions

Improvements for producing biogas from winter beet should comprise increasing the dry matter yield without increasing the efforts for cultivation, if possible. Examining the silage process more closely could help to further increase methane yield.

Contact:
Dr. Nicol Stockfisch
[1]Institut für Zuckerrübenforschung
an der Universität Göttingen,
Holtenser Landstr. 77, 37079 Göttingen, Germany
Tel. +49 551 505 62-30
Email: stockfisch@ifz-goettingen.de

Dr. Susanne Ohl
[2] Institute of Agricultural Engineering,
Christian-Albrechts-University of Kiel
Max-Eyth-Str. 6, 24118 Kiel, Germany
Tel. +49 431 880-1544
Email: sohl@ilv.uni-kiel.de

SPONSORED BY THE
Federal Ministry of Education and Research
PTJ Projektträger Jülich Forschungszentrum Jülich
Nordzucker
strube research