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Sorrel and reed canary grass in southern Norway

By HENRIK KOFOED NIELSEN[1]

[1]*University of Agder, Serviceboks 509, 4898 Grimstad, Norway*

Summary

Reed canary grass *Phalaris arundinacea* 'Bamse' was established in Grimstad, Norway in 2002. Average yield has been 7250 $kg_{d.m}.ha^{-1}$ by spring harvest. Water content was some years quite high and makes reed canary grass a risky crop. In 2006 a small test field with a sorrel hybrid, *Rumex patientia* × *Rumex tianschanicus* 'Rumex OK-2' was established. Sorrel developed quite well and produced a harvestable crop already in August 2007. Yield in 2007 of the flower stalks alone was 5200 $kgd.m.ha^{-1}$. In 2008 we discontinued fertilization and hoeing. The yield subsequently decreased in 2008 to 2370 $kgd.m.ha^{-1}$ of flower stalks. Relative high water content in the stalks and new green leaves in August makes a swather or artificial drying necessary.

Key words: *Rumex, phalaris*, yield, water content, calorific value, sorrel, reed

Introduction

In 2000 the University of Agder established a large energy park in Grimstad, Norway. Focus was on renewable energy for teaching, demonstration and R&D. In 2002 a 0.3 ha field with energy crops was added to the energy park. Crops are evaluated for growth, yield, mortality, health, and they are examined for characteristics regarding combustion and gasification. In order to achieve a sustainable production the energy crops are neither sprayed nor irrigated. Fertilization levels are chosen according to custom for the respective crops. Our area with energy crops may be regarded as very small, but Norway has in total less than 10 ha willow short rotation coppice, and nearly no grassy energy crops.

Materials & Methods

In the energy park the soil is medium sandy with a clay content of about 5%. The mould content is stabilized to 3.0–4.5 % after 5 cm of composted sewage sludge and saw dust was harrowed in prior to the establishment in 2002. The mean annual precipitation is 1230 mm and mean annual temperature is 6.9°C.

Reed canary grass

At the establishment in 2002 an area of 750 m² was established with reed canary grass, *Phalaris arundinacea* 'Bamse' 30 kg seeds ha^{-1}. Reed canary grass is mostly grown as a fodder crop in Norway, and the varieties are developed as fodder crops. As we wanted an energy crop for spring harvest, we selected 'Bamse' from Svalöf Weibull AB, Sweden as a suitable variety for southern Norway. New varieties for energy and fibre are bred in Norway, but are not commercially available yet.

Reed canary grass is fertilised with 85 kg nitrogen per ha per year in the form of mineral fertilizer also containing phosphorus and potassium. Every year in March or April depending on the climate, six blocks of 12 m² reed canary grass are harvested with a motor scythe.

Sorrel

In May 2006 an additional crop of a sorrel hybrid, *Rumex patientia* × *Rumex tianschanicus* 'Rumex OK-2' was established on a small area of 90 m². The seeds were obtained from Arne E Jørgensen, Danish international consulting ApS and sowed into rows 30 cm apart with a rate of 11 kg ha^{-1} which corresponded to 460 seeds m^{-2}. This sorrel hybrid has only been introduced a very few places in the Nordic countries. Sorrel is a perennial, which can be harvested dry continuously in the summer with high yields for more than 10 years according to Ust'ak & Ust'akova (2004). Sorrel produces a lot of seeds, 500 kg ha^{-1}, enough for 100 ha with 5 kg ha^{-1}, which is the recommended sowing rate by (Ust'ak & Ust'akova, 2004). In addition it has very few requirements for soil, fertilization and climate (Bassam, 1998).

The fertilization of sorrel followed the recommendations of Ust'ak & Ust'akova (2004). Mineral fertilizer with phosphorus, potassium and 65 kg nitrogen ha^{-1} yr^{-1} the first two years, and then no fertilization the third year. The row distance permits hoeing, which was carried out in 2006 and in spring 2007.

Sorrel is harvested in August, see Fig. 1. The harvesting procedure is first to cut the flower stalk with secateurs, then the remaining leaves are harvested with a motor scythe. Leaves were harvested the first time in 2008. The lot consists of six blocks of 4.8 m² each.

Fig. 1. Harvesting of flower stalks in sorrel with secateurs 6 August 2006.

Results

Both crops have developed quite well and look healthy. Reed canary grass has only had minor weed problems. A few thistles and mugworts have been manually removed every year. The first harvest was carried out March 2004. Sorrel reached a height of up to 2.5 m and produced a harvestable crop already in 2007. The winter survival was not an issue.

Annual yield in reed canary grass has varied from 6100 kg d.m..ha^{-1} to 9000 kg d.m..ha^{-1} (Table 1). The average level of 7250 kg d.m..ha^{-1} is very similar to trials in Sweden (Landström *et al.*, 1996). The unexpected increased yield in 2008 is probably due to the weather.

Yield

Table 1. *Yield and combustion characteristics of reed canary grass established in 2002.*

Year	2004	2005	2006	2007	2008
Harvest date	30 Mar	19 Apr	24 Apr	2 Apr	3 Mar
Water content, %	11.9	8.6	25.4	9.5	57.2
(SEM)	(0.44)	(0.30)	(1.67)	(0.78)	(2.21)
Yield, kg $_{d.m}$.ha^{-1}	6650	8000	6540	6100	9000
(SEM)	(344)	(144)	(98)	(289)	(276)
Ash, % $_{d.m.}$	2.6	2.3	3.0	n.d.y.	n.d.y.
Net calorific value, MJ kg $_{d.m}^{-1}$.	16.6	16.46	16.88	n.d.y.	n.d.y.

n.d.y. Not determined yet

Table 2. *Yield and water content of sorrel established in 2006*

Year	2007	2008
Date	6 Aug	15 Aug
Water content stalks, %, (SEM)	58.3 (3.35)	35.2 (4.99)
Yield, flower stalks, kg d.m..ha^{-1} (SEM)	5170 (469)	2370 (68)
Water content, leaves, % (SEM)	n.d.	89.9 (0.16)
Yield, leaves, kg $_{d.m}$.ha^{-1} (SEM)	n.d.	370 (42)
Total, yield, kg $_{d.m}$.ha^{-1}	n.d.	2750
Total water content	n.d.	62.7

n.d. Not determined

In sorrel the yield in 2007 of the flower stalks alone was 5200 kg $_{d.m}$..ha^{-1} ((Table 2). In 2008 we stopped the fertilization according to Ust'ak & Ust'akova (2004). And we stopped hoeing as we expected sorrel could compete with the weed. The yield subsequently decreased in 2008 to 2370 kg $_{d.m}$.ha^{-1} for flower stalks and 2750 kg $_{d.m}$..ha^{-1} in total including leaves. The leaves account for only 13.6 % of the total harvestable dry matter.

Water content

The water content is crucial in order to get storable material with water content below 20 %, which normally is the limit (Gylling, 2001; Wieneke, 1972; Landström *et al.*, 1996).

Reed canary grass

As can be seen in Table 1 reed canary grass was harvested with water contents of 25.4% and 57.2% the two poorest years. However, the median value of 11.9% is slightly better than the 16.4% reported by Landström *et al*. (1996) for five test locations in Southern Sweden. The strategy is to wait until the snow has gone and the grass is dry, but before growth starts. In 2008 average daily temperature was 5.7ºC the last 15 days before the harvest and soil temperature was 3–4ºC in depth of 10 cm (Vips-Landbruk.no, 2008). The grass started growing, and we decided to harvest in spite of the high water content. However in the last week of March we got frost and snow, and lower water content could have been possible without damaging the crop.

Sorrel

The flower stalks dry very uneven and new leaves sprout in August. This makes it difficult to

choose the right harvesting time for sorrel in our climate. The first year we checked the water content of the flower stalks on 6 August and 24 August. In this time span the water content decreased from 58.3% to 27.8% (Table 2). In 2008 the water content of the flower stalks was 35.2% on 15 August. All values are above the requested water content below 20%. A normal harvester will normally also harvest the green leaves and cause a much higher water content in the harvested material, see table 2. But the leaves only contribute marginally to the yield of total dry matter.

Combustion characteristics

In reed canary grass the ash content was quite low, approximately 3% of dry matter and the net calorific value averaged 16.7 MJ/$kg_{d.m}$. All these findings are similar to Burvall (1997). Measurements of the missing combustion characteristics in Table 1 and 2 will follow later this autumn.

Discussion

Reed canary grass develops well and according to Landström *et al*. (1996) the yield should decrease annually for our type of climate after the second ley year. This was also observed here until the fifth ley year, where the yield even was better than in the second ley year. One explanation might be optimal water supply in 2007, when precipitation was 610 mm May-August compared to 309 mm in 2006 (Vips-Landbruk.no, 2008). It will be interesting to follow the yield in 2009 and the subsequent years. High water contents are difficult to avoid as there are only few good harvesting days due to the relatively moist and warm coastal climate.

The achieved yields in sorrel are very low compared to Ust'ak & Ust'akova (2004) and Bassam (1998). Explanations may be:

- Sorrel did not produce new plants from the abundant amount of seeds.
- The leaves did not cover the soil totally.
- Discontinued fertilization the second year.

Due to weed problems hoeing will be reintroduced in 2009. The level of yield in sorrel can so far not compete with our other energy crops. In addition the development of new leaves simultaneous with the drying of flower stalks in August necessitates special drying measures to achieve a storable crop. One solution is to harvest the flower stalks above the leaves, but a cutting height of 50 cm will decrease the yield substantially. A more reasonable option may be use of a swather and drying in the field before baling of the crop. Additional drying in-door is possible and reported by Hutla & Manzancová (2004).

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