BREEDING REED CANARYGRASS AS AN ENERGY OR FIBRE CROP BY USING LOCAL COLLECTED WILD POPULATIONS

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ABSTRACT
Reed canarygrass (*Phalaris arundinacea L.*) has become interesting as an industrial crop in Sweden. The grass can be used as biofuel or fibre raw material for pulp production. New varieties have to be developed, with a quality different from forage varieties. High stem/leaf-ratio, low content of ash and elements like silica, potassium and chlorine are important breeding goals. A Swedish project, aiming to evaluate local reed canarygrass populations, shows that there is some variation in these morphological and chemical characters which can be utilised in a breeding program.

KEYWORDS
Reed canarygrass, plant breeding, biofuel, paper pulp, fibre

INTRODUCTION
Biofuel or fibre as raw material for pulp production may be one non-food alternative production on arable land. A number of agricultural species have been screened to find suitable crops to be grown as an alternative to cereals. So far reed canarygrass is considered as the most interesting under Swedish conditions (Andersson and Lindvall, 1996). A new production system - the delayed harvesting system- is under development, which means that the grass is left on the field during winter and harvested the following spring (Olsson, 1994). Industrial use of reed canarygrass requires a completely different quality compared to forage. When straw material is used as fuel the main problems are related to the ash. It melts at low temperature and cinders (Burvall and Hedman, 1994). These characters are correlated to mineral content, mainly silica (Si) and potassium (K). High content of chlorine (Cl) causes corrosion. When used for pulp production the difficulties are dewatering capacity and recovering the pulping chemicals because of high content of Si and K (Paavilainen and Torgilsson, 1994). Consequently, together with high dry-matter yield, low mineral and Cl content are important objectives when breeding for bioenergy as well as fibre use.

When the reed canarygrass appeared to be of interest as an industrial crop, a new breeding program was initiated by Svalöf Weibull AB in 1989. Reed canarygrass is native and widely distributed all over Sweden, and a comprehensive collection of local ecotypes were done in several parts of the country to gather a basic material. Some of the populations from northern part of the country have been tested in a project aiming to evaluate wild Swedish populations of reed canarygrass for yield potential, quality and adaptation to different climate factors.

MATERIAL AND METHODS
The project was planned with the objective to test as many local collected populations as possible under several climatic conditions. Field trials, with 18 entries, were established at 7 locations around the country in 1991 and 1992. As the amount of seed per population was limited, plants were raised in the greenhouse and transplanted to the field in small plots (3.75 m^2, 60 plants/plot) to form the trial. Local populations are named after their area of origin. SWN RF9201, SWN RF9208, SWN RF9209 and SWN RF9214 are breeding populations resulting from open pollinated crossings between local material and European gene bank accessions. American ('Palaton', 'Venture') and Norwegian ('Lara', VåSr8401) varieties were used as standards. Fertiliser was applied in the spring at the same rate as are generally given to timothy variety trials at each location in the spring (60-100 kg N, about 30 kg P and 70 kg K). The trials were harvested for three, and in some cases four years. Two replications were harvested in late autumn, the other two in following spring. Dry matter yield was measured at each harvest time, samples for chemical analyses were taken when harvesting in spring. Plant height and stem/leaf-ratio were scored each year. Part of the samples have been analysed for content of ash, K, Si and Cl. Results from the trials planted in 1992 are presented here.

RESULTS AND DISCUSSION
A combined analysis of variance over populations, locations and years showed highly significant variation in dry-matter (DM) yield among the populations (Table 1). The yield in kg DM per hectare ranged from 6410 to 12500 with a mean of 9670. The average results show that some of the local populations have a yielding capacity as good as or better than the standard varieties when comparing average yield over all locations and three crop years (Figure 1). The Nordic varieties and most of the breeding populations were among the highest yielding; American varieties were found in the middle of the range. The populations 'Risudden', 'Hietases', 'Hedenäset' and 'Seskarö', originating from the northernmost province of Sweden, Norrbotten, yielded significantly lower then the others when compared over all locations and years.

Northern populations are however more persistent and winter hardy than material with more southern origin, therefore the southern populations showed yield with increasing stand age. The visually scored stem/leaf-ratio did not differ significantly between populations with the exception of the populations from Norrbotten which were more leafy.

Significant variation in the chemical components of interest, with the exception of Cl, was found between the populations (Table 1). The ash content, in per cent of DM, varied from 2.85 to 5.26 with a mean of 3.60. The variation in K content, in g per kg DM, ranged from 0.73 to 1.95. The varieties from USA, 'Palaton' and 'Vantage', and SWN RF9208, a breeding population with Polish origin, showed the highest values, the northernmost populations the lowest. Corresponding values for Si varied from 1.08 to 1.6, with significant higher values for populations with northern origin. The variation in Cl content, 4.20 - 5.10 g/kg DM, was not significant, neither between populations nor among locations. The aim of this project was to evaluate the potential of the local reed canarygrass populations as source material for the development of varieties for industrial use. A high DM yield per unit area is of greatest importance. The results showed that there were local populations, randomly selected for the trials, which outyielded available commercial varieties. There should therefore be good possibilities of developing high yielding varieties adapted to our climate by selection among and within local collected populations. The idle plant is supposed to have a tall, robust stem and preferably no leaves. The variation in scored stem/leaf-ratio in this project was quite small, but the visual impression of these trials, as well as other breeding material of reed canarygrass, is that there is a great variation in stem/leaf-ratio within the species which can be utilised in the breeding work. The evaluation of the chemical characters is not yet completed. Experiences from another Swedish

reed canarygrass investigation shows that soil type has a great influence on the ash and mineral content (Burvall and Hedman, 1994). A significant variation between locations was found in this project (Table 1). The results also indicate that there is some genetic variation in mineral content between the populations. Since the analyses are expensive, it has so far not been possible to screen single plants for variation. However, as there is some variation between populations it should be possible to breed for low ash and mineral content.

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Table 1
Mean, range and significance for DM-yield and quality characters for reed canarygrass populations in Swedish screening trials

	Mean	Range	Significance among populations	Significance among locations
DM-yield kg ha-1	9670	6410 - 12500	***	***
Ash, % of DM	3.60	2.85 - 5.26	**	***
Si, g kg-1 DM	1.32	1.07 - 1.60	**	***
K, g kg-1 DM	1.08	0.73 - 1.95	*	**
Cl, g kg-1 DM	4.58	4.2 - 5.1	ns	ns

* p< 0.05 ** P< 0.005 *** P<0.001

Figure 1
Dry matter yield of Swedish local populations, breeding material and commercial varieties in Swedish screening trials. Mean yield over 7 locations and 3 years