The role of Botanical Garden of PBAI in Bydgoszcz in promoting the crop and usage of perennial C4 grasses in Poland

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Introduction

Among the over 300 grass species known from Poland, there are about 160 species well established in the flora (~130 native with C3 photosynthesis pathway and ~30 aliens), and nearly 150 ephemerophytes, occasional escapers from cultivation or cultivated species (Mirek and Piękoś-Mirkowa 2002). Grasses from other climatic zones have been introduced to our country in recent years, especially as ornamental plants and as a source of biomass for energy purposes. The studies conducted since the 1990s in Botanical Garden of PBAI in Bydgoszcz, where the National Grass Collection is located, have contributed considerably to the popularization of C4 grasses in Poland.

Methods

The taxons of C4 grasses gathered in the National Grass Collection were obtained from gene banks and by the exchange of seeds with other botanical gardens. The obtained materials (seeds, plants) were planted out in rows after their reproduction in the collection without any replications on the patches of 1.5 m^2 with rows adjusted to the requirements of the species and the quantity of the planting material available. Assessment of the collection was initially made using biomass growth as the main selection criterion. After reproduction further evaluation was undertaken in experimental plots located within the area belonging to the botanical garden as well in other regions throughout Poland where the C4 species may have potential for usage such as for energy generation, re-cultivation of waste areas, or as the source of livestock forage. Research on the suitability of selected C4 grass species for ensilage at different growth phases was carried out in Department of Animal Nutrition and Feed Management of University of Technology and Life Science in Bydgoszcz in compliance with the standard procedures (AOAC 1995). In the biomass collected from the plants growing on contaminated lands, the content of heavy metals was determined by atomic emission spectrometry method.

Results

The observations made in the grass collection set up in Botanical Garden of PBAI in Bydgoszcz provided clear evidence of the usefulness of perennial C4 grasses for biomass production in Poland. The introduction of these new plants for cultivation is well justified by the lack of (native grass species with capability to produce up to 20 t/ha of dry matter/year in average humidity conditions Table 1). Forage from *Andropogon gerardi*, *Miscanthus sacchariflorus* and *Panicum virgatum* produced good silage, especially when cut at early phases of plant development when the content of structural carbohydrates (NDF, ADF) was high (Table 2). This highlighted the potential of C4 grasses for to usage as forage for animal feeding purposes, especially as a supplementary source of green matter in periods of insufficient access to traditional silage sources (Majtkowski *et al.* 2009).

Table 1. Yield of perennial C4 grasses in the experiments of Botanical Garden of PBAI in Bydgoszcz (November 2006).

Species	Fresh weight (t/ha)	Moisture (%)	Yield (t DM /ha)
Andropogon gerardi	17.2	34.6	11.2
Miscanthus giganteus	39.7	47.8	20.7
Miscanthus sacchariflorus	25.8	45.2	14.1
Miscanthus sinensis	35.5	46.2	19.1
Panicum virgatum	18.4	29.8	12.9
Spartina pectinata	17.6	48.6	9.0

The experiments conducted on waste areas showed the usefulness of some species for the phytoremediation of soils contaminated with heavy metals. However, reducing the heavy metal concentrations below the threshold value for pellets and briquette used in energy generation remains an important problem to solve (Table 3).

Conclusion

The observations made in Botanical Garden of PBAI in Bydgoszcz indicated the potential for the cultivation of perennial C4 grass species in the climate conditions experienced in Poland. Not only did they proved to be more productive than native species, but they are more versatile providing biomass for multiple applications such as a

Table 2. Chemical composition of tested C-4 grasses in beginning of flowering (2009 season).

Species	DM (%)	Content of dry matter (%)							
		OM	CP	CFA	CFI	NFE	NDF	ADF	HEM
Andropogon gerardi	32.07	94.64	5.98	1.46	38.61	48.59	72.81	41.94	30.87
SD	2.15	0.65	0.82	0.24	2.36	2.19	2.48	2.31	1.89
Panicum virgatum	31.01	94.38	6.35	1.40	38.76	47.87	74.24	42.46	31.78
SD	2.01	0.47	0.60	0.30	2.02	2.35	1.66	1.74	1.83
Miscanthus sacchariflorus	43.96	95.61	5.93	1.48	35.81	52.39	71.01	40.32	30.69
SD	4.06	0.49	1.07	0.27	1.97	2.21	1.71	2.40	1.65

SD – standard deviation. DM - dry matter. OM - organic matter. CP - crude protein. CFA - crude fat. CFI - crude fibre. NFE - N-free extract. NDF - neutral detergent fraction. ADF - acid detergent fraction. HEM – hemicellulose

Table 3. The results of the analysis of heavy metals in the samples of material taken from the experimental area in Bytom in mg/kg in November 2011.

No.	Species	Cd	Cr	Pb	Zn
1	*Andropogon gerardii*	1.49	0.19	117.14	198.58
2	*Miscanthus giganteus*	25.16	21.61	226.87	215.09
3	*Miscanthus sacchariflorus*	0	15.43	0	490.51
4	*Panicum virgatum*	12.99	7.27	196.42	266.65
5	*Spartina pectinata*	2.98	1.85	71.77	214.70
Threshod value for pellets and briquette in accordance to norm PN-EN 14961-2:2011 i PN-EN 14961-3:2011		0.5	10	10	100

source of nutritious forage in animal feeding, conservation as silage, phytoremediation of soils and a renewable fuel source for energy generation.

References

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