NORTH AMERICAN GRASS SPECIES IN RECLAMATION OF COAL-MINING AREAS IN POLAND

W. Majtkowski
Plant Breeding & Acclimatization Institute, Botanical Garden, ul. Jezdziecka 5, 85-687 Bydgoszcz, POLAND

ABSTRACT
Suitability of perennial grass species as a main decorative element was evaluated during reclamation of a coal-dump in Bierun near Katowice. Materials for the above testing were species selected from grass collection of Botanical Garden of PBAI in Bydgoszcz. The most promising species were: *Carex* grayi (sedge), *Andropogon gerardi, A. scoparius* and *Spartina michauxiana* (grasses from North America flora), *Elymus racemosus, Koeleria cristata, Melica altissima, Miscanthus sacchariflorus* (European or Asian origin). Addition of bio-gel positively affected plant development, while no significant differences were observed between different levels of fertilizers.

KEYWORDS
coal-mining dump, reclamation, grasses, ornamental species

INTRODUCTION
In the Katowice region coal-mining spoils cover more than 1.6% of the total regional area (Patrzalek 1990). Present technologies are only able to use a small amount of post-industrial spoils or to put them back into excavation. That is why the most effective way for recovering a coal-mining dump is biological reclamation.

The Botanical Garden of Plant Breeding and Acclimatization Institute in Bydgoszcz, with co-operation of the Institute of Basic Environment Engineering of Polish Academy of Sciences in Zabrze is working on a project of reclamation of a coal-mining dump. This project takes into account recreational- and park-type usage of the waste area. The proposed way of reclamation reverts to historical traditions of this region, well known for fishing and hunting before it was destroyed by industry.

In the above program turf grasses were the pioneer plant that initiated soil-forming processes. Later, decorative species will be the major aspect of the reclaimed area. On new dumps it is useless to plant trees and shrubs, because of the risk of spontaneous inflammability caused by deep root system (oxidation of pyrite in presence of oxygen and water).

The major goal of the above project is to select from the grass collection of Botanical Garden of PBAI species of both high decorative value and legal input requirements.

MATERIALS AND METHODS
Grass species from the collection of Botanical Garden of PBAI were used in the above program. Origin of species (i.e. extremely dry and poor sites) as well as aesthetic values were taken into account during selection of species. In spring of 1995 the following species were reproduced: *Achnatherum calamagrostis, Elymus racemosus, Melica altissima, Miscanthus sacchariflorus, Pennisetum flaccidum, Spartina michauxiana, Spodiopogon sibiricus.*

The experiment in Bierun was established in the middle of May 1995, after initial levelling of ground surface. Plants were planted in three replications, in two variants of fertilization level (50 and 100 kg N per ha). Twenty-four plants per species were planted on plot of 1.5 m x 1.5 m in four rows, six plants per row (spacing - 0.25 x 0.30 m). For 12 plants per plot bio-gel was added to the root zone.

During the field evaluation following traits were observed:
- general aspect - visual scoring on 0-9 scale (9 - the best, 0 - dead plants),
- dried leaves (% of all leaves on plant),
- morphological traits: plant height (cm), leaf length and width (cm), number of inflorescence,
- root development (g per plant),
- yield of dry matter (g per plant).

Due to bad development of *Achnatherum calamagrostis* and *Spodiopogon sibiricus* in September 1995 six additional species were planted: *Andropogon gerardi, A. scoparius, Koeleria glauca, Panicum virgatum, Trisetum sp. and Carex grayi* (sedge).

RESULTS AND DISCUSSION
Among tested species different reactions to site conditions resulting in differences in growth were observed. The best growing species were: *Miscanthus sacchariflorus, Pennisetum flaccidum, Spartina michauxiana* (stoloniferous species) and *Andropogon gerardi, A. scoparius, Carex grayi, Koeleria glauca* (tuft plants). General aspects for the above species were of highest values (Table 1).

Addition of bio-gel was beneficial for tested plants, while no significant difference was observed in the case of two levels of fertilisation. It was confirmed by results of morphological measurements, especially plant height and number of inflorescence. Length of inflorescence as well as length and width of leaves were typical traits for species, so there is no effect of treatments (i.e. fertilisation levels and addition of bio-gel) on these traits. Above relations were also confirmed by measurements of root development (Table 2) and yield of plant dry matter.

In the biological bringing of waste land into cultivation, especially herbaceous plants are pioneer organisms. Mixture of some species protect soil from water and wind erosion. Mostly papilionaceous plants are the humus-forming plants with the ability to increase nitrogen content in soil. Patrzalek (1984) claims that planting of coal-dump areas with grasses and papilionaceous plants should precede afforestation. Herbaceous plants strongly decrease the chemical soil weathering process. Turf on dump surface absorbs rain water and is also an effective inhibitor of exothermic changes of pyrite. It also protects coal dumps against self-ignition. Most suitable species for sodding of dumps were fescues - red fescue (*Festuca rubra* L.), hair fescue (*Festuca capillata* Lam.) and shade fescue (*Festuca heterphylla* Lam.).

Positive effect of herbaceous plant mixtures in initial phase of reclamation of waste areas, especially on poor soils is confirmed by works done in North-Czechoslovakian Brown Coal Basin (Patejdl 1963). Species of low site requirements were used for sodding: *Anthylis vulneraria* L., *Melilotus albus* Med., *Trifolium hybridum* L., *Medicago lupulina* L., *Lupinus polyphyllus* Ldl., *Vicia villosa* Roth. and *Festuca rubra* L.

CONCLUSIONS

1. Good development and high decorative value of tested grass species enable us to widely utilize the above for biological recultivation of post - industrial waste areas.
2. Different levels of fertilization gave no effect on plant development.
3. Bio-gel had positive effect on plants, especially root systems.

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Table 1

Results of evaluation of general aspect in 1996 season (different levels of fertilization).

Genus, species	General aspect [scale 1-9]			
	FERTILIZATION			
	I level		II level	
	May	August	May	August
Andropogon gerardi	8.0	7.0	9.0	9.0
Andropogon scoparius	5.0	7.0	5.0	7.0
Elymus racemosus	8.3	7.0	8.7	7.0
Koeleria glauca	9.0	8.0	9.0	8.0
Melica altissima	9.0	7.3	9.0	7.0
Miscanthus sacchariflorus	9.0	7.7	9.0	8.0
Panicum virgatum	7.0	7.0	8.0	6.0
Spartina michauxiana	8.0	7.3	8.0	8.0
Spodiopogon sibiricus	6.7	5.0	4.3	6.3
Carex grayi	-	-	9.0	9.0

*-no signif. of difference

Table 2

Results of evaluation of root development measurements [g/plant] (without or with addition of biogel).

Genus, species	FERTILIZATION					
	I level		II level		Average	
	Biogel +	Biogel -	Biogel +	Biogel -	Biogel +	Biogel -
Elymus racemosus	69.7*	44.7	91.0*	64.7	80.3*	54.7
Miscanthus sacchariflorus	268.7	94.7	611.3	138.3	440.0	116.5
Pennisetum flaccidum	71.0	49.7	75.0	62.3	73.0	56.0
Spartina michauxiana	172.7	100.7	648.3	256.3	410.5	178.5

*-signif. of difference for biogel addition at P=90%