VIRGINIA FANPETAL-BASED DIGESTION RESIDUE
;ED FOR VIRGINIA FANPETAL FERTILIZATION PURPOSES

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*Abstract: This paper presents the results of the impact of the Virginia fanpetals
tion residue-based fertilization upon the height and diameter of sprouts, biomass yield
oncentration of N, P, K, Mg and Ca in the plants of Virginia fanpetals. A larger
ter and height of stems and yield of green and dry matter was observed after having
higher doses of the Virginia fanpetals-derived digestion residue. More effective
tion of the concentration of magnesium was noticed after the application of the tested
e and potassium than in the case of the residue applied solely. It was shown that
ligestion residue of Virginia fanpetals can be used as a fertilizer.*

oduction

Due to the need for production of biomass in possibly the largest
tities, alternative crops gain more and more importance in our country. Among
rops that are most often cultivated for energy purposes, willow, maize, rape
Virginia fanpetal should be mentioned [Denisiuk 2005; Sławiński ET AL
]. Virginia fanpetal, not so long ago was not yet well known in Poland, and it
plant that may be comprehensively used as: fodder, for recultivation and
y purposes. Usefulness of Virginia fanpetal for energy purposes, according to
wiec and Smoliński [2011], is proven by its high content of hydrogen and
n.

However, every crop needs to be supplied with nutrients in order to
uce optimal yield. The literature refers to optimal fertilizer doses for Virginia
tal, that depending on soil quality are kept within the following limits: 100-
g $N \cdot ha^{-1}$, 50-150 kg $K_2O \cdot ha^{-1}$, 80-120 kg $P_2O_5 \cdot ha^{-1}$ [Bujak 2004]. Fertilization
nly contributes to the quantity of biomass but also to the content of elements
e biomass [Kalembasa and Wiśniewska 2006, 2008, 2010, Borkowska and
iski 2008]. Fertilization does not necessarily have to be based on application
nineral fertilizers that are expensive and require high energy input into
ization. Digestion residues obtained from gasification of biomass should be

used as fertilizer, especially for energy crops. This opportunity is indicated by Piechota [2011]. The research aimed at assessment of the impact of the Virginia fanpetal methane-based digestion residue upon the yield and the content of a selection of macro-elements in *Sida hermephrodita* Rusby.

Methodology

The pot experiment was conducted in the vegetation hall of the University of Warmia and Mazury in Olsztyn as four experiment re-makes in polyethylene pots type Kick-Brauckmann - 10 kg of soil containing glanulometric composition of hard sandy clay. Doses of the digestion residue were set out according to the nitrogen content (Table 1). Due to the little content of potassium, the tested residue was additionally applied to combinations undergoing fertilization. The soil was mixed with the digestion residue or the digestion residue and potassium, and next the vases were filled in with it to plant seedlings of the Virginia fanpetal. The digested residue was obtained in result of the methane-based digestion of the Virginia fanpetal carried out at the Biotechnology Department of the University of Warmia and Mazury in Olsztyn. The soil water content of 70% of the water content at field capacity was maintained throughout the whole vegetation period.

The digestion residue represented alkaline reaction. In the chemical content of the digestion residue, nitrogen was dominant, whereas sodium represented the lowest percentage share (Table 2).

The Virginia fanpetal was harvested after the vegetation period. The cut crops were weighed, measured and the weight of green sprouts was determined. Chopped and dried - in the temperature of 105°C - biomass was re-weighed in order to specify the content of dry matter. The samples prepared in that way were crushed and underwent analyses. The experiment samples were mineralized in H_2SO_4 with the oxidant H_2O_2. After mineralization the following was specified: N – distillation method, P - colourimetric method (vanadium-and-molybdenum method), K and Ca - AES method (atomic emission spectrometry), Mg - ASA (atomic absorption spectrometry).

Table 1.

Design of Experiment

No	Treatment	g per pot				
		N	P	K	Ca	Mg
1	Control	0	0	0	0	0
2	Digestion Residue– 228 g per pot	0.5	0.11	0.22	0.21	0.038
3	Digestion Residue – 456 g per pot	1.0	0.21	0.44	0.42	0.075
4	Digestion Residue – 684 g per pot	1.5	0.32	0.66	0.63	0.113
5	Digestion Residue – 228 g per pot + K	0.5	0.11	0.5	0.21	0.038
6	Digestion Residue – 456 g per pot + K	1.0	0.21	1.0	0.42	0.075
7	Digestion Residue – 684 g per pot + K	1.5	0.32	1.5	0.63	0.113

Table 2.

Chemical composition of Virginia fanpetal Digestion Residue

nponent	Ca	K	Mg	Na	P	N
per kg :en matter	0.924	0.959	0.165	0.059	0.471	2.190

:s

The digestion residue significantly and noticeably lengthened the sprouts ·ginia fanpetal (Table 3). Each larger dose of the residue improved the ncy that was still better in effect of higher potassium content, after repeated ıtion of this component. It bears noting that Virginia fanpetal grown on the :prived of digestion residue grew the smallest. This indicates the need to e this plant.

The higher the dose of the digestion residue was, the thickness of stems of :ted plant was bigger (Table 3). Potassium was of lesser importance for :ss of stems – the same doses of digestion residue used without or with um resulted in similar effects.

On the basis of the conducted research it was proven that the digestion : significantly increased the quantity of green and dry matter of the tested ıfter gasification of the Virginia fanpetal-based biomass (Exhibit 1). The :e in the quantity of biomass produced by the Virginia fanpetal was :antly dependent on the dose of digestion residue. This residue along with ts, indispensable for growth and development of plants, were added to the itrogen is the element that contributes most to the yield output. The research : indicated that the Virginia fanpetal benefits from more intensive potassium ation.

The research output of other authors proved beneficial impact of nitrogen he length of stems of the Virginia fanpetal and the quantity of produced s [Borkowska and Styk 2003]. In another paper Borkowska et al [2009] that nitrogen did not have any impact upon the density of stems but it :antly made them higher, on the other hand better developed and longer were obtained after having been fertilized with higher doses of phosphorus. ling to Kusia et al [2008] the yield potential of the tested plant is big, :r it is dependent on soil quality and fertilization.

Table 3.

Height and Diameter of the Virginia fanpetal Sprouts

	Treatment	Plant height [cm]	Diameter of Sprout [mm]
	Control	23.3	4.63
	Digestion Residue – 228 g per pot	40.5	5.38
2	Digestion Residue – 456 g per pot	42.0	6.00
4	Digestion Residue – 684 g per pot	56.0	7.13
5	Digestion Residue – 228 g per pot + K	42.8	5.90
6	Digestion Residue – 456 g per pot + K	49.5	5.35
7	Digestion Residue – 684 g per pot + K	60.0	6.40
	$NIR_{0,01}$ - $LSD_{0,01}$	3.50	1.20

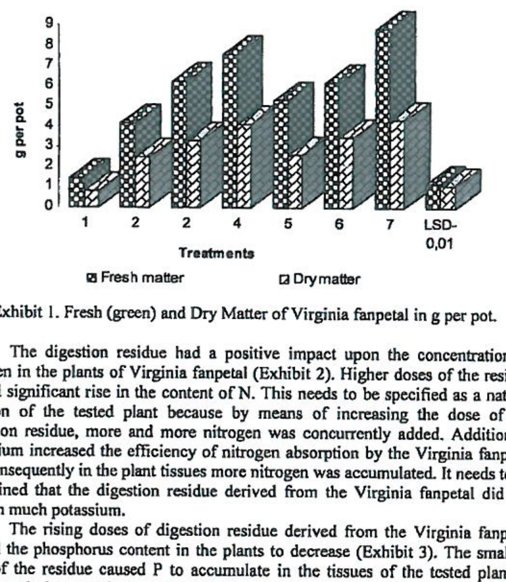

Exhibit 1. Fresh (green) and Dry Matter of Virginia fanpetal in g per pot.

The digestion residue had a positive impact upon the concentration of nitrogen in the plants of Virginia fanpetal (Exhibit 2). Higher doses of the residue caused significant rise in the content of N. This needs to be specified as a natural reaction of the tested plant because by means of increasing the dose of the digestion residue, more and more nitrogen was concurrently added. Addition of potassium increased the efficiency of nitrogen absorption by the Virginia fanpetal and consequently in the plant tissues more nitrogen was accumulated. It needs to be underlined that the digestion residue derived from the Virginia fanpetal did not contain much potassium.

The rising doses of digestion residue derived from the Virginia fanpetal caused the phosphorus content in the plants to decrease (Exhibit 3). The smallest dose of the residue caused P to accumulate in the tissues of the tested plant in significantly lower volume. This could be caused by the significant content of Ca in the digestion residue used for the research purposes and by retarding phosphorus to the form insoluble in water, e.g.: $Ca_3(PO_4)_2$. Conversion of phosphates into lesser dissoluble forms will limit its absorption by plants.

Potassium content, similarly to nitrogen, linearly increased concurrently with increasing dose of the digestion residue with which this component had been ɨ (Exhibit 4). Additional potassium-based fertilization resulted in further ɨing of the quantity of the component accumulated in the plants.

Magnesium concentration in the dry matter of the tested plant was ɨly proportional to the potassium content (Exhibit 5). This inter-relation is xplainable. Potassium is the antagonist of magnesium and strongly limits its tion. Along with the digestion residue, magnesium and potassium were however potassium content was over 5.8-fold higher than magnesium t in the residue tested under this research. So, it is understandable that nal potassium-based fertilization contributed to further decrease in the t of Mg in the Virginia fanpetal. Among all the elements used under the h, the content of calcium in the Virginia fanpetal did not vary much (Exhibit

Fertilization does not only influences productivity of plants but also ces the chemical content. BORKOWSKA AND LIPIŃSKI [2008] and MBASA AND WIŚNIEWSKA [2008, 2010] obtained fairly varied content ro-elements in the plants of Virginia fanpetal. Similarly, the output of the h conducted on our own indicates that depending on the nutrient content in e accumulation of N, P, K and Mg may vary to a great extent. Concentration ective elements also depends on the developmental stage of a plant. Thus in Virginia fanpetal-derived biomass, the content of mineral components may ed as it is reported by various authors.

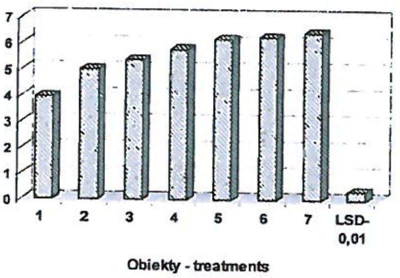

Exhibit 2. Content of N in Dry Matter of Virginia fanpetals.

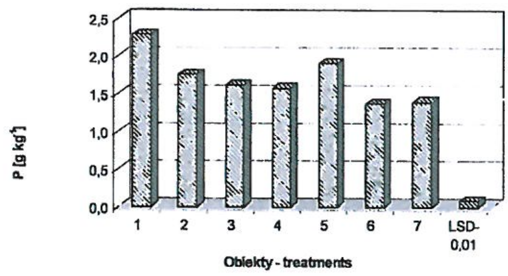

Exhibit 3. Content of P in Dry Matter of Virginia fanpetals.

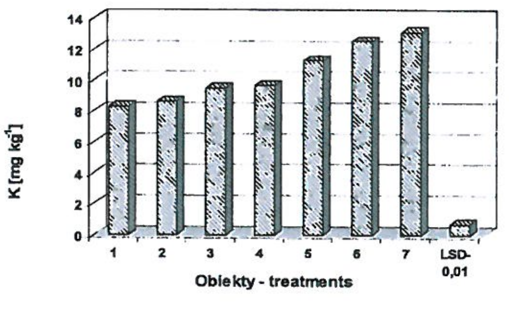

Exhibit 4. Content of K in Dry Matter of Virginia fanpetals.

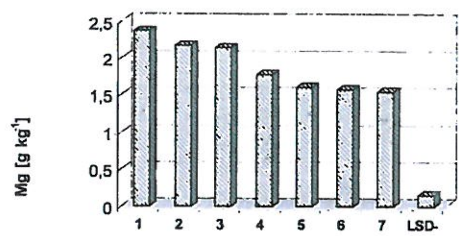

Exhibit 5. Content of Mg in Dry Matter of Virginia fanpetals

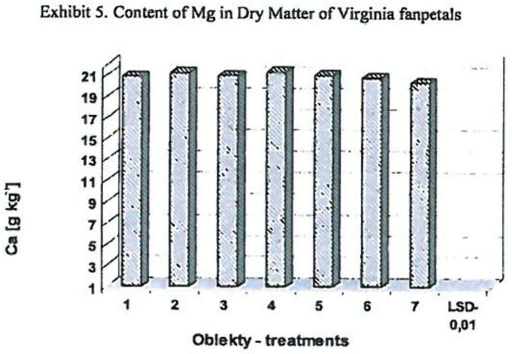

Exhibit 6. Content of Ca in Dry Matter of Virginia fanpetals.

nclusion

The digestion residue derived from the Virginia fanpetal has a beneficial impact upon the height and thickness of sprouts of the Virginia fanpetal and the quantity of green and dry matter.

The Virginia fanpetal reacted positively to more intensive potassium-based fertilization.

3. Potassium applied along with the residue limited the concentration of magnesium in the Virginia fanpetal,

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