NÁRODNÉ POĽNOHOSPODÁRSKE
A POTRAVINÁRSKE CENTRUM
VÝSKUMNÝ ÚSTAV
AGROEKOLÓGIE

Vplyv melioratívnej dávky pôdneho kondicionéra na báze humínových kyselín HUMAC Agro na úrodu fytomasy, ligno-celulózovú kvalitu a energetickú hodnotu prosa prútnatého *Panicum virgatum* L.

Effect of Soil-Applied Humic Ammeliorative Amendment Improver HUMAC Agro on the Yield Potential, Ligno-Cellulose Quality and Calorific Value of *Panicum virgatum* L.

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NPPC - VÚA Michalovce

Dávky minerálnech živín NPK (kg.ha^{-1}, PK v ox. forme) a humínového preparátu HA (HUMAC Agro, obsah humínových látok 62%) podľa variantov/ošetrení.

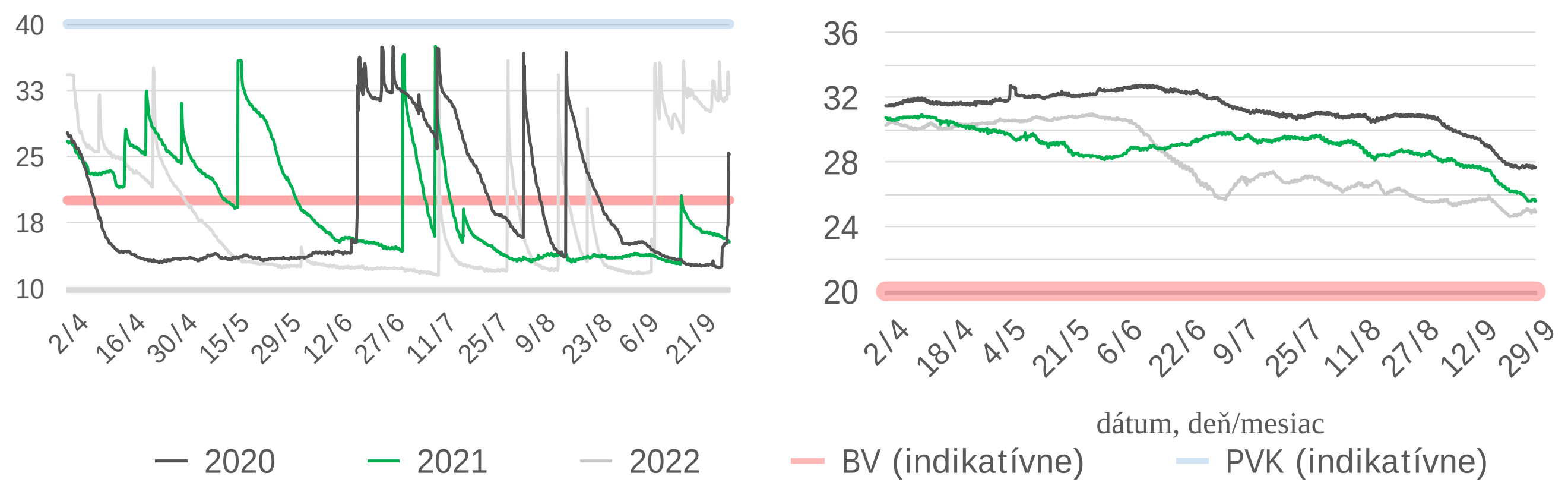
Ošetrenie / variant	N	P	K	ΣNPK	HA
2018 – pred-sejbová dávka					
HA	0	0	0	0	1000
NPK	70	50	100	220	0
UC	0	0	0	0	0
2018, 2019, 2020, 2021, 2022 – ročné dávky na začiatku vegetácie (koniec marca)					
HA	70	0	0	70	0
NPK	70	0	0	70	0
UC	0	0	0	0	0

Priebeh ukazovateľov počasia a pôdnej klímy, Michalovce 2018/22.

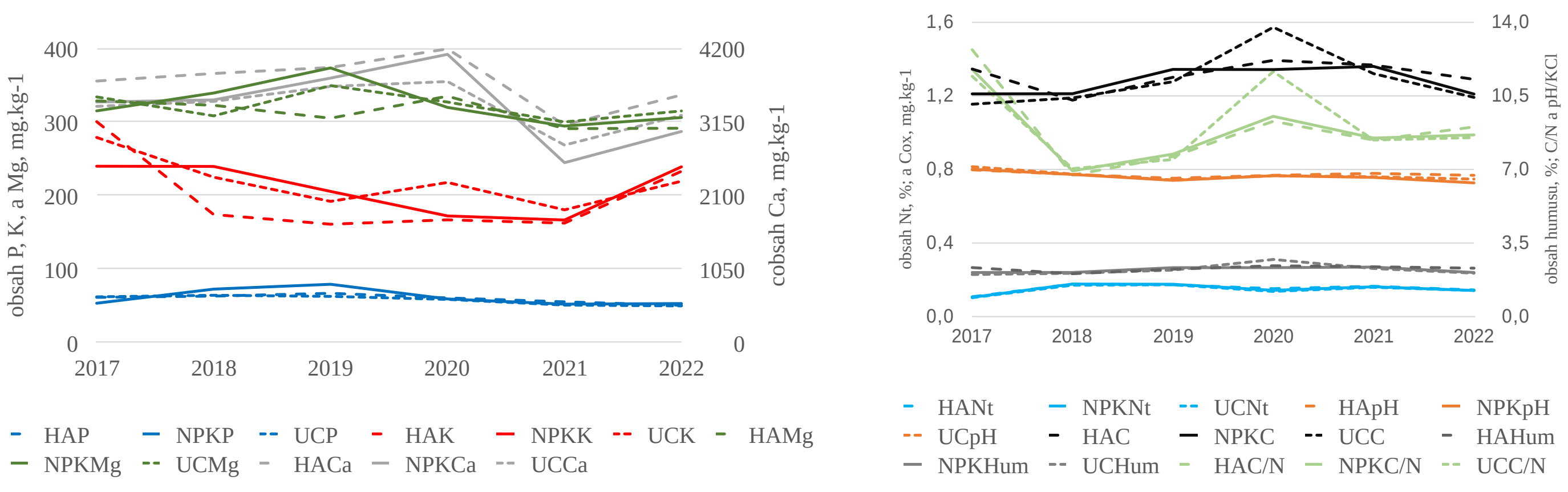
Rok	Počasie			Ornica, hĺbka 15 cm			Podornica, hĺbka 45 cm		
parameter	Teplota, °C	Zrážky, mm	HTk, koef.	Vlhkosť, % VWC	Teplota, °C	Vodivosť, mS/cm	Vlhkosť, % VWC	Teplota, °C	Vodivosť, mS/cm
2018	20,0	221	0,61	25,5	17,7	0,097	33,0	17,0	0,133
2019	18,4	445	1,34	22,6	17,4	0,076	31,2	16,7	0,101
2020	17,3	388	1,25	18,8	16,5	0,063	29,0	15,9	0,070
2021	17,3	372	1,19	19,1	16,2	0,059	28,1	15,7	0,059
2022	18,3	288	0,87	17,8	17,2	0,047	25,1	16,7	0,059
priemer	18,3	343	1,04	20,8	17,0	0,068	29,3	16,4	0,084

HTk – hydrotermický koeficient podľa Seljaninova (HTk = zrážky/(priemerná teplota x počet dní x 0,1); kde: > 2,00 nadbytok vlahy, 1,01-2,00 dostatok vlahy, 1,0 zrážky sa rovnajú výparu, 0,51-0,99 nedostatok vlahy, 0,31-0,50 sucho, <0,3 katastrofické sucho

Priebeh vlhkosti pôdy v plne produkčných rokoch v hĺbke 20 cm (vľavo) a 50 cm (vpravo), pridané hodnoty hydrolimitu poľnej vodnej kapacity PVK a bodu vädnutia BV
(40 a 20%, resp. v rozpetí 35-46 a 17–23% pre ílovito-hlinitú ťažkú pôdu).

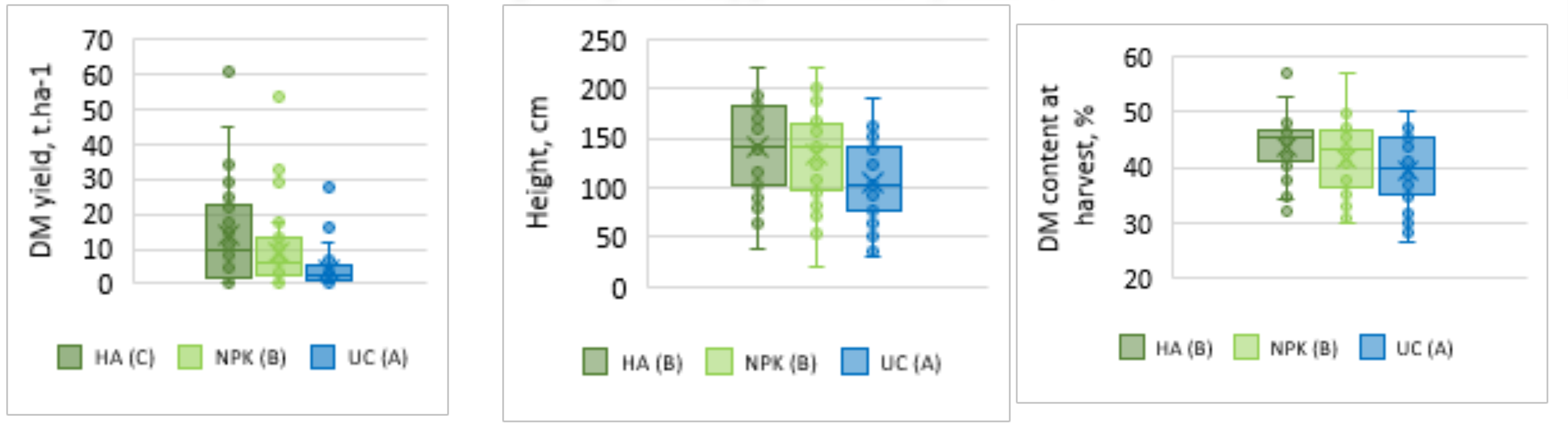


Časový vývoj vybraných hlavných chemických vlastností pôdy (obsah Nt, P, K, Ca, Mg, C-ox, humusu, pH/KCl a pomeru C/N), podľa ošetrení/variantov (HA, NPK, UC).



PORADIE ODRÔD: EG 1101 > BO MASTER > EG 1102 > KANLOW > ALAMO > CARTHAGE > NJ ECOTYPE; PORADIE VARIANTOV/OŠETRENÍ: HA > NPK > UC

Box plot pre úrodu sušiny (vľavo), výšku rastlín (stred), a obsah sušiny pri zbere (vpravo) podľa ošetrení/variantov (HA - NPK - UC); zobrazené minimá, prvý kvartil, medián, priemer, tretí kvartil a max. hodnoty; písmená A-B-C indikujú skupinu homogenity podľa MANOVA pre zdroje variability pri 5% hladine významnosti.



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Effect of a Soil-Applied Humic Ameliorative Amendment on the Yield Potential of Switchgrass *Panicum virgatum* L. Cultivated under Central European Continental Climate Conditions

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Abstract: The yield potential of switchgrass was verified by testing seven cultivars in a small-scale experiment carried out from 2018 to 2022 on Gleyic Fluvisol under Central European conditions. The treatments are as follows: pre-sowing (i/HA) soil humic preparation Humac AGRO (based on leonardite) with an ameliorative dose of 1000.0 kg ha^{-1} or (ii/NPK) basic nutrition with a dose of 220.0 kg ha^{-1} NPK; an annual dose of 70 kg ha^{-1} N was applied to both treatments (HA, NPK) and compared to (iii/UC) untreated control. A dry matter (DM) yield of 9.02 t ha^{-1} was achieved in the total average, which varied from 0.05 t ha^{-1} to 60.64 t ha^{-1}. The yield was affected mainly by years (F-ratio 106.64), then by nutrition (F-ratio 79.03), followed by cultivars (F-ratio 56.87), and finally by replications (F-ratio 0.00). Switchgrass productivity increased according to the utility year; however, the driest year (2020—388 mm, 2021—372 mm, and 2022—288 mm) changed the order of the three full utility years (12.44, 19.13, and 7.73 t ha^{-1} DM, respectively). HA gives the highest DM yield of 13.69 t ha^{-1} on average with values of 9.19 and 4.19 for NPK and UC, respectively. The cultivars order was EG 1101 > BO Master > EG 1102 > Kanlow > Alamo > Carthage > NJ Ecotype (21.15, 12.48, 8.14, 7.70, 6.34, 4.47, and 2.89 t ha^{-1} DM when ranking average yield or 60.64, 45.20, 29.92, 29.15, 17.87, 9.86, and 5.93 t ha^{-1} DM when ranking maximal yields).

Keywords: switchgrass; dry matter yield; Gleyic Fluvisol; soil fertility; mineral fertilization; leonardite; low-input

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1. Introduction

Switchgrass (*Panicum virgatum* L.) is a medium- to high-yielding, warm-season perennial grass suitable for low-input growing on marginal soils [1–3]. Considered to be one of the most promising energy crops indigenous to North America [4], switchgrass was selected as a candidate bioenergy crop for the USA in the early 1980s, while research on it in Europe started a decade later [5]. However, initial efforts to grow switchgrass for energy purposes in European countries were not very successful due to severe reasons, leading to the low chance of success in establishing the stands. This reasons mainly include seed dormancy, unmanaged protection against problematic grassy weeds in the initial period, and a lack of information regarding the adaptability of cultivars under various growing conditions [6,7]. Currently, the re-introduction of this grass to European countries is supported by the suitability of its phytomass for multifaced use in different 2nd-generation technologies, wherein the re-emerged concept of marginal soils has been met too.

Due to the search for novel energy crops with large increases in phytomass, low habitat requirements, and high resistance to diseases and pests [1], an interest in C4-type plant switchgrass has increased worldwide beyond warm-season areas alone [8]. This is connected with the fact that switchgrass is characterized by a wider ecological

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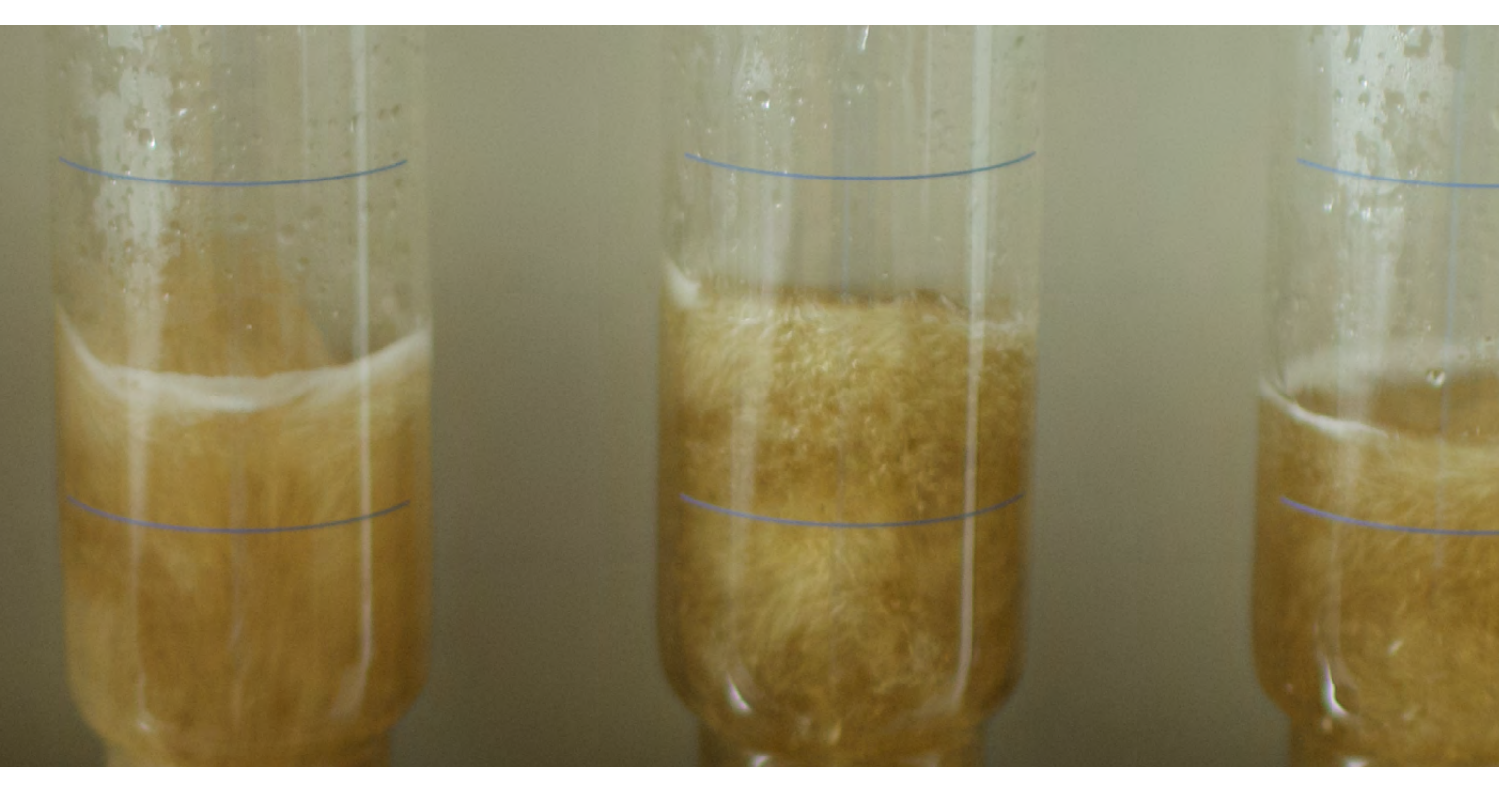

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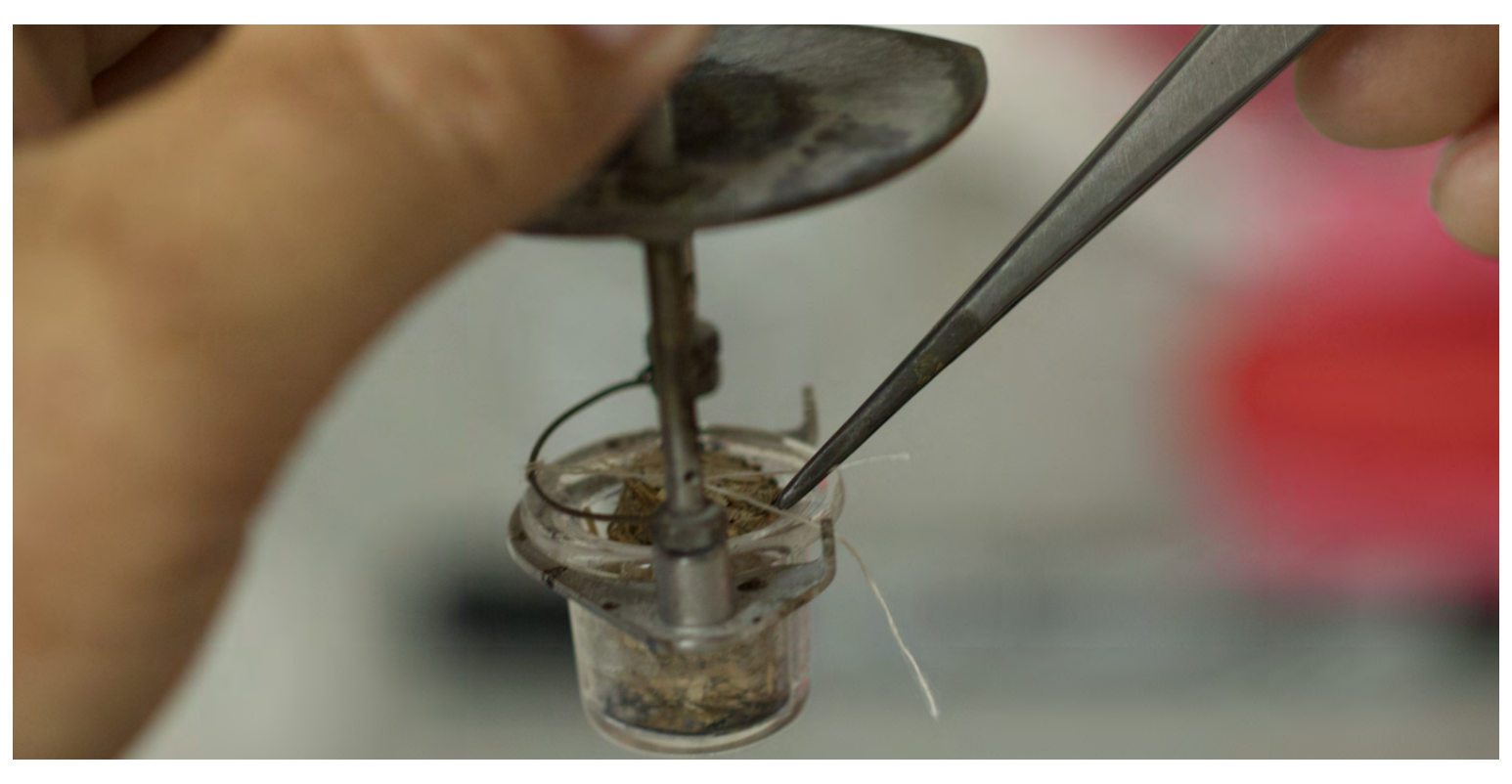
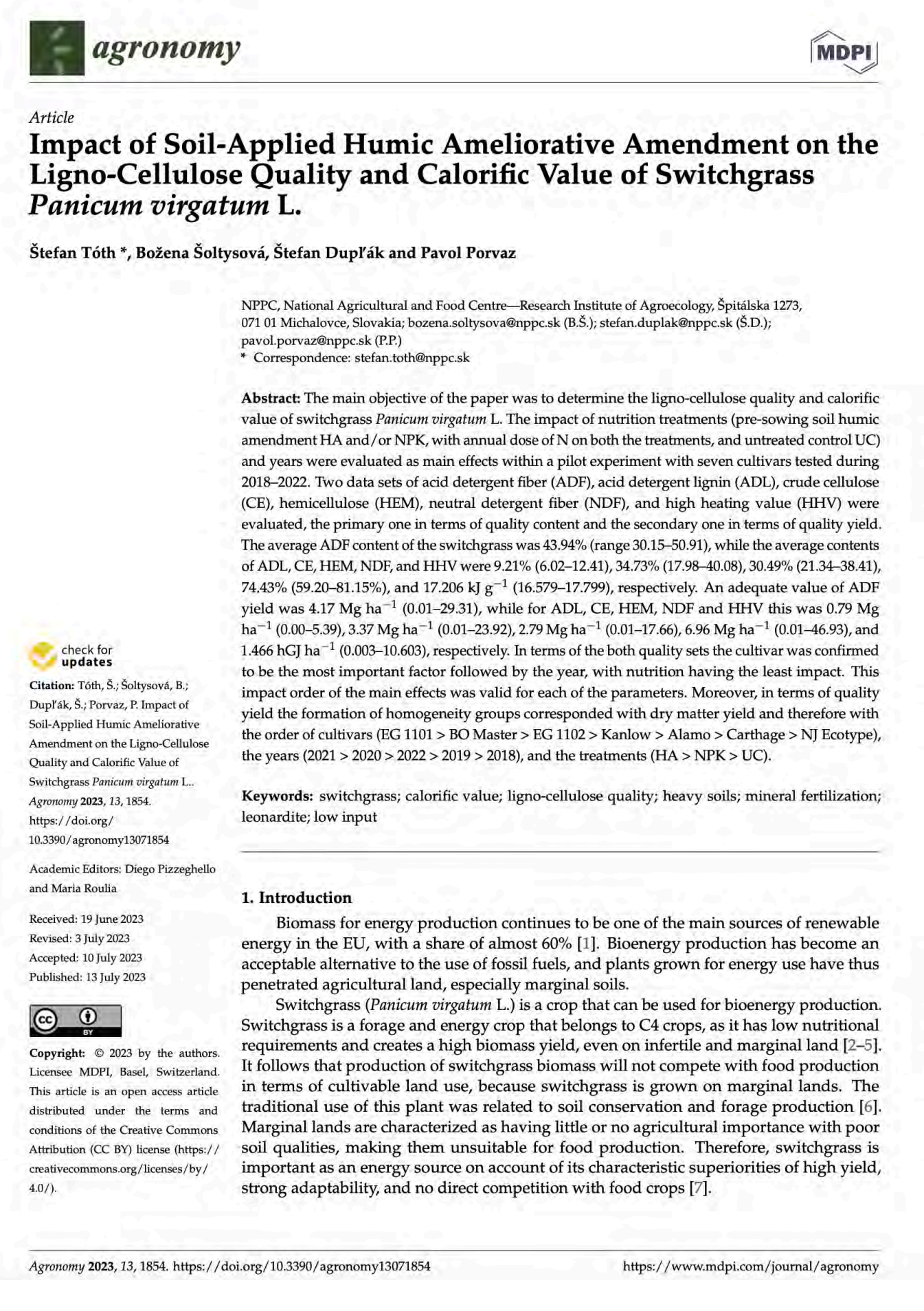


VKLADANIE ZÁPALNEJ ŠNÚRY

JEDNICE DOSAHUJÚ VÝŠKU 2 METRE



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Impact of Soil-Applied Humic Ameliorative Amendment on the Ligno-Cellulose Quality and Calorific Value of Switchgrass *Panicum virgatum* L.

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Abstract: The main objective of the paper was to determine the ligno-cellulose quality and calorific value of switchgrass *Panicum virgatum* L. The impact of nutrition treatments (pre-sowing soil humic amendment HA and/or NPK, with annual dose of N on both the treatments, and untreated control UC) and years were evaluated as main effects within a pilot experiment with seven cultivars tested during 2018–2022. Two data sets of acid detergent fiber (ADF), acid detergent lignin (ADL), crude cellulose (CE), hemicellulose (HEM), neutral detergent fiber (NDF), and high heating value (HHV) were evaluated, the primary one in terms of quality content and the secondary one in terms of quality yield. The average ADF content of the switchgrass was 43.94% (range 30.15–50.91), while the average contents of ADL, CE, HEM, NDF, and HHV were 9.21% (6.02–12.41), 34.73% (17.98–40.08), 30.49% (21.34–38.41), 74.43% (59.20–81.15%), and 17.206 kJ g^{-1} (16.579–17.799), respectively. An adequate value of ADF yield was 4.17 Mg ha^{-1} (0.01–29.31), while for ADL, CE, HEM, NDF and HHV this was 0.79 Mg ha^{-1} (0.00–5.39), 3.37 Mg ha^{-1} (0.01–23.92), 2.79 Mg ha^{-1} (0.01–17.66), 6.96 Mg ha^{-1} (0.01–46.93), and 1.466 hGJ ha^{-1} (0.003–10.603), respectively. In terms of the both quality sets the cultivar was confirmed to be the most important factor followed by the year, with nutrition having the least impact. This impact order of the main effects was valid for each of the parameters. Moreover, in terms of quality yield the formation of homogeneity groups corresponded with dry matter yield and therefore with the order of cultivars (EG 1101 > BO Master > EG 1102 > Kanlow > Alamo > Carthage > NJ Ecotype), the years (2021 > 2020 > 2022 > 2019 > 2018), and the treatments (HA > NPK > UC).

Keywords: switchgrass; calorific value; ligno-cellulose quality; heavy soils; mineral fertilization; leonardite; low input

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1. Introduction

Biomass for energy production continues to be one of the main sources of renewable energy in the EU, with a share of almost 60% [1]. Bioenergy production has become an acceptable alternative to the use of fossil fuels, and plants grown for energy use have thus penetrated agricultural land, especially marginal soils.

Switchgrass (*Panicum virgatum* L.) is a crop that can be used for bioenergy production. Switchgrass is a forage and energy crop that belongs to C4 crops, as it has low nutritional requirements and creates a high biomass yield, even on infertile and marginal land [2–5]. It follows that production of switchgrass biomass will not compete with food production in terms of cultivable land use, because switchgrass is grown on marginal lands. The traditional use of this plant was related to soil conservation and forage production [6]. Marginal lands are characterized as having little or no agricultural importance with poor soil qualities, making them unsuitable for food production. Therefore, switchgrass is important as an energy source on account of its characteristic superiorities of high yield, strong adaptability, and no direct competition with food crops [7].

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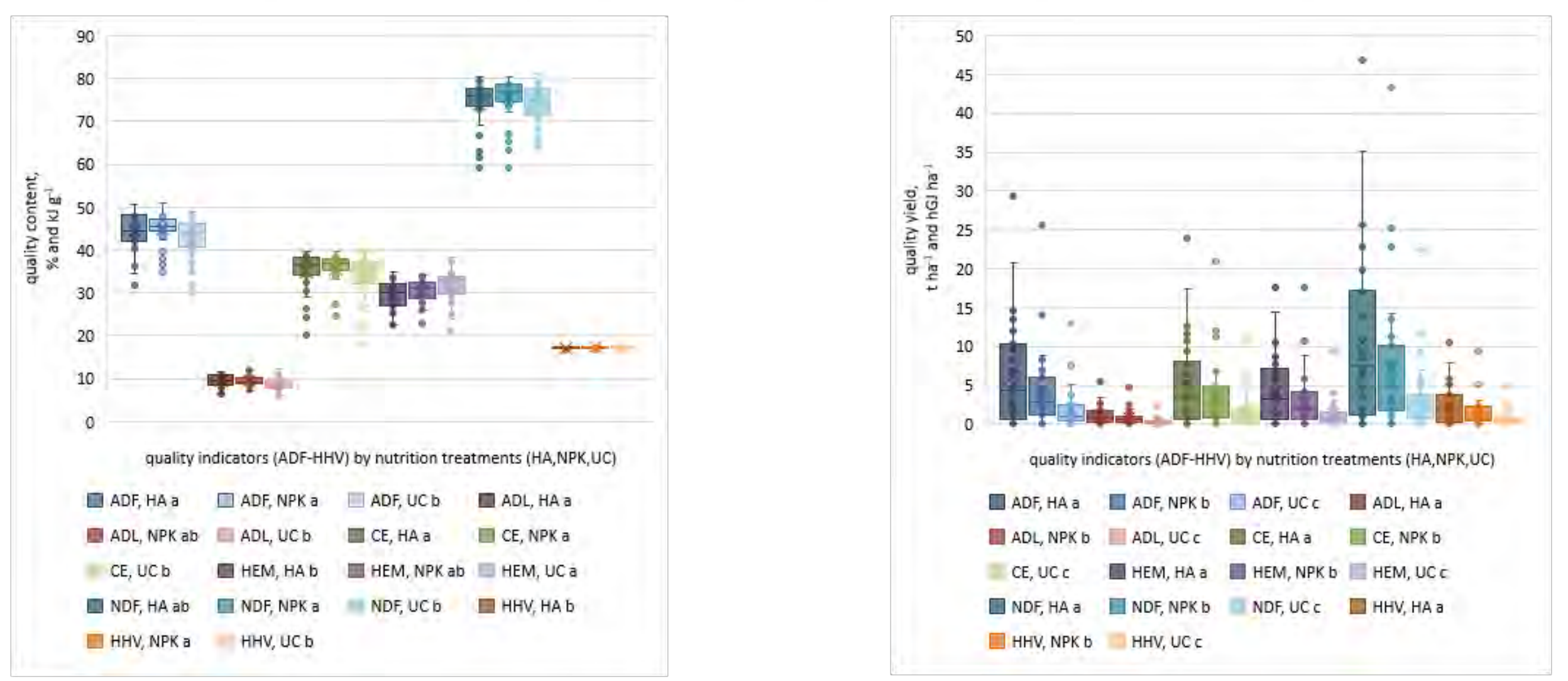
Box plot pre kvalitu z hľadiska obsahu (vľavo) a množstva (vpravo), podľa ošetrení/variantov (HA-NPK-UC), pre parametre ligno-celulózovej (ADF-ADL-CE-HEM-NDF, resp. acidodetergentnú vlákninu a lignín, celulózu, hemicelulózu a neutrálnodetergentnú vlákninu) a kalorickej hodnoty (HHV, resp. spaľovacie teplo); znázornené sú minimá, prvý kvartil, medián, priemer, tretí kvartil a max. hodnoty; písmená a-b-c indikujú skupinu homogenity podľa MANOVA pre zdroje variability pri 5% hladine významnosti.



RHIZÓMY, Z KTORÝCH ODNOŽE VYRASTAJÚ

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