Basal, potential and relative respiration with dependence on applied crop residues and bio-stimulators in Haplic chernozems

Bazálna, potenciálna a relatívna respirácia a jej ovplyvnenie aplikáciou rastlinných zvyškov a biotimulátorov rozkladu v černozemi

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Abstract

In this paper is looked for answers on following questions: 1. Which from crop residues and bio-stimulators more affected basal, potential and relative respiration? 2. Which from crop residues and bio-stimulators more affected the changes of potential and relative respiration dynamics during incubation? Therefore a laboratory experiments were established. In pots were added soil samples of loamy Haplic Chernozems (Ch), the crop residues of winter wheat (WR) and oil rape (RR) and bio-stimulators BETA-LIQ (B) and TRICHOMIL (T) were used. Variants of laboratory experiment were following: Ch, Ch+WR, Ch+WR+B, Ch+WR+T, Ch+RR, Ch+RR+B, Ch+RR-T. During incubation optimal temperature and moisture for decomposition of organic matter were kept. During incubation the basal and potential respiration were determined, and the values of relative respiration were calculated. The crop residues of RR had marked effect on increase the basal and potential respiration and on stability of organic substances as compared to crop residues of WR. Crop residues of WR had more marked effect on decreasing of nitrogen utilization. A higher amount of easy-utilized organic substances was found in variants with applied crop residues of WR as well. Tested bio-stimulators had effect on increase of basal respiration, but their effect was more marked in variants with WR. The effect of bio-stimulators was also very intensive in the end of incubation in variants with crop residues of winter wheat. From tested bio-stimulators B had more marked effect on basal and potential respiration. More easy-utilized organic substances were observed in variant with B as well as B had more marked effect on utilization of carbon and stability of organic substances as compared to T. The crop residues of WR had more marked effect on decrease the potential respiration dynamics than crop residues of RR and from bio-stimulators T, but only in variants with applied crop residues of WR.

Keywords: relative and potential respiration, crop residues, BETA-LIQ, TRICHOMIL

Abstrakt

Práca sa zameriava na hľadanie odpovedí na nasledujúce otázky: 1. Ktoré z použitých pozberových zvyškov a biostimulátorov výraznejšie pôsobia na bazálnu, potenciálnu a relatívnu respiráciu? 2. Ktoré z použitých pozberových zvyškov a biostimulátorov výraznejšie pôsobia na dynamiku zmien potenciálnej a relatívnej respirácie počas inkubačného obdobia? Problematika bola riešená formou nádobových pokusov. Do nádob sa navážilo 200 g zeminy - černozem kultizemná (Ch), pridali rastlinné zvyšky pšenice letnej formy ozimnej (WR) a kapusty repkovej pravej (RR) a pridali biostimulátory BETA-LIQ (B) a TRICHOMIL (T). Založené boli nasledovné varianty: Ch, Ch+WR, Ch+WR+B, Ch+WR+T, Ch+RR, Ch+RR+B, Ch+RR-T. Počas inkubácie sa udržiavali optimálne podmienky pre rozklad organickej hmoty a sledovala sa bazálna, potenciálna a vypočítavala relatívna respirácia. Pozberové zvyšky kapusty repkovej pravej mali výrazný vplyv na zvýšenie hodnôt bazálnej, potenciálnej respirácie a tiež na stabilitu organických látok v porovnaní s pozberovými zvyškami pšenice letnej formy ozimnej. Z pozberových zvyškov sa výraznejšie na znižovaní využiteľnosti dusíka podieľali zvyšky pšenice letnej formy ozimnej, rovnako v týchto variantoch bolo viac ľahko využiteľných organických látok. Aj pridané biostimulátory sa podieľali na zvýšení hodnôt bazálnej respirácie, pričom ich vplyv bol výraznejší vo variantoch s pozberovými zvyškami pšenice letnej formy ozimnej. Ich účinnosť sa začala opäť prejavovať ku koncu inkubácie. Z testovaných biostimulátorov výraznejší vplyv na bazálnu a potenciálnu respiráciu mal BETA-LIQ. Viac ľahko využiteľných organických látok bolo vo variantoch s BETA-LIQom. BETA-LIQ mal i výraznejší vplyv na využívanie uhlíka a stabilitu organických látok ako TRICHOMIL. Na dynamiku zmien poklesu potenciálnej respirácie mali vplyv pozberové zvyšky pšenice letnej formy ozimnej v porovnaní s kapustou repkovou pravou. Z biostimulátorov mal výraznejší vplyv TRICHOMIL, ale iba vo variantoch s pozberovými zvyškami pšenice letnej formy ozimnej.

Kľúčové slová: Potenciálna a relatívna respirácia, pozberové zvyšky, BETA-LIQ, TRICHOMIL

Introduction

The respiration is very important parameter for studying the anthropogenic soil loading together with determination of N_2 fixed by bacteria, amount of microbial biomass, dehydrogenaze activity and humification [7]. Microbial respiration is defined as oxygen take-off or releasing of CO_2 by bacteria, fungi, fimbrias and protosoas and it include the gas interchange in aerobic and anaerobic metabolism. Soil respiration is influenced by decomposition of organic matter and it can be observed in field or laboratory conditions [1, 8]. Respiration activity is complex parameter which included activity of microbial biomass and specific activity of microorganisms as well. High respiration can be a result of high activity the small society of soil organisms or also low activity of great society [9, 13]. Respirometric tests are used for evaluation of soil biological activity. It can be used for assessing of mineralization level of organic substances from soil sources and substances added to soil. Basal respiration is defined as respiration without addition of organic substances to soil. Source induced respiration (SIR) is soil respiration measure after addition of sources as glucose, nitrogen substances [1]. When an abundance of fresh, decomposable tissue is added to the soil, the appearance of easily decomposable and often water-soluble compounds, such as sugars, starches, and amino acid, stimulates an almost immediate increase in metabolic activity among the soil microbes. Soon microbial activity is at its peak, energy is being rapidly liberated, and carbon dioxide is being formed in large quantities. As they multiply and increase their biomass, the microbes are also synthesizing new organic compounds. The microbial biomass at this point may account for as one-sixth of the organic matter in a soil. The intense microbial activity may even stimulate the breakdown of some resistant soil organic matter, a phenomenon known as the priming effect [2]. Added organic substances to soil led to higher emissions of carbon in the form of CO_2 and higher degree of microbial activity as showed the respiration measures. Soils with applied fresh organic wastes evolved higher amounts of CO_2 than soil where the compost was applied. Amount of CO_2 decrease by residual content of soil organic matter [6].

The objective of the study was to get the answers on following questions: 1. Which from crop residues and bio-stimulators more affected basal, potential and relative respiration? 2. Which from crop residues and bio-stimulators more affected the changes of potential and relative respiration dynamics during incubation?

Material and methods

The soil samples of loamy Haplic Chernozems (Ch) were taken from Ap horizon (Dražovce). The crop residues of winter wheat (WR) and oil rape (RR) and from tested biopreparates BETA-LIQ (B) and TRICHOMIL (T) were used. The laboratory experiments were established in small containers (volume 0.22 dm^3) in incubation time 4, 7, 10, 14, 28, 60, 93, 180 days. In pots was ratio soil : crop residues 50:1, with improving C:N ratio by adding N fertilizers. During incubation optimal temperature (23-25°C) and moisture (50-60% of the field water capacity) for decomposition of organic matter were kept.

Variants of laboratory experiment:

A Haplic Chernozems (Ch)

B Haplic Chernozems + wheat residues (Ch+WR)

C Haplic Chernozems + wheat residues + beta-liq (Ch+WR+B)

D Haplic Chernozems + wheat residues + trichomil (Ch+WR+T)

E Haplic Chernozems + rape residues (Ch+RR)

F Haplic Chernozems + rape residues + beta-liq (Ch+RR+B)

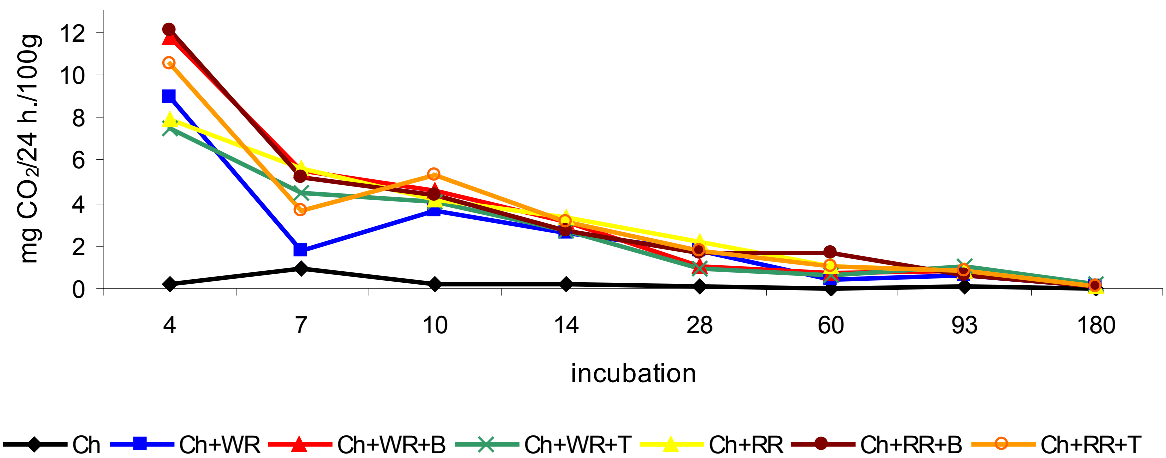
G Haplic Chernozems + rape residues + trichomil (Ch+RR+T)

During incubation time the amount of CO_2 was determined [5]. Except the basal respiration, the values of potential respiration were determined and also the values of relative respiration were calculated. Obtained results were statistically evaluated (ANOVA).

Results and discussion

Added crop residues and bio-stimulators increased CO_2 production in initial phase. The most marked increase in values of basal respiration was determined after 4 days of incubation in variants with crop residues of oil rape (figure 1), what

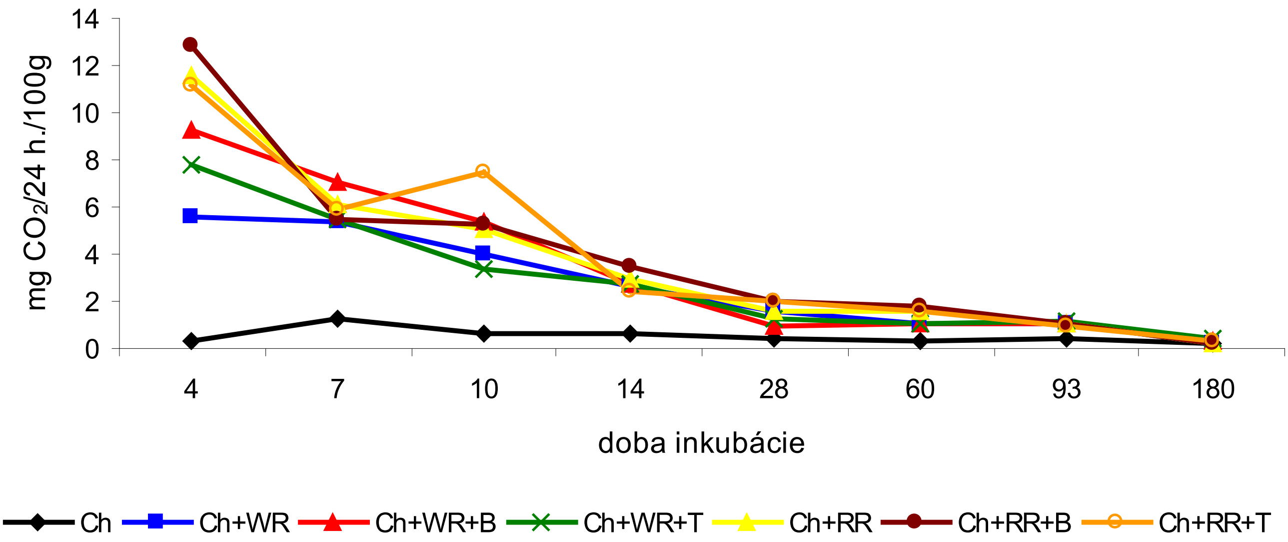
obr. 1. Dynamika bazálnej respirácie počas inkubácie
fig. 1. Dynamic of basal respiration during incubation



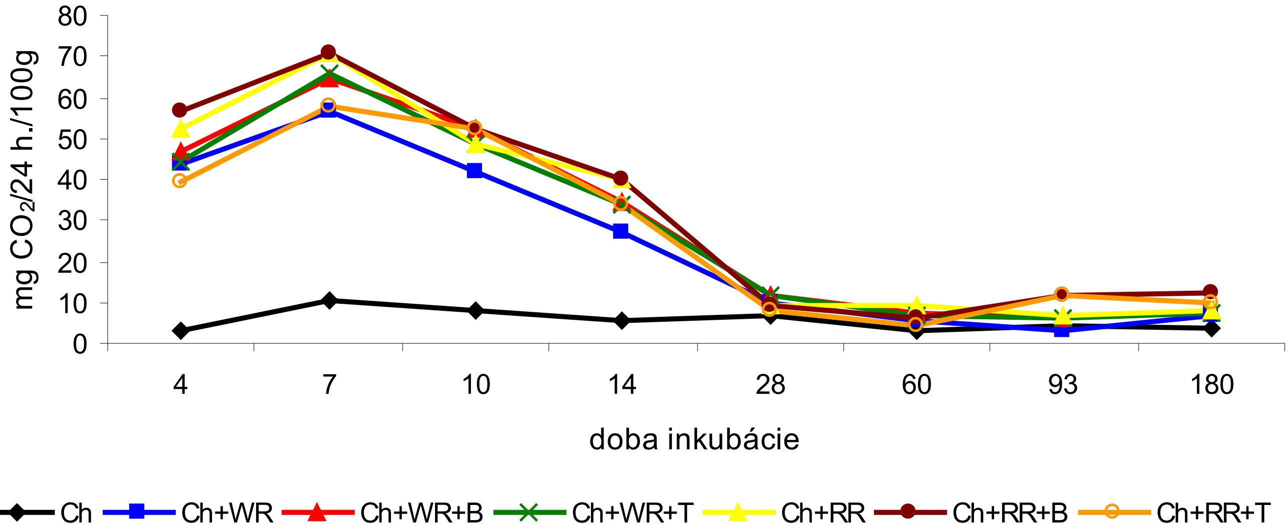
is in agreement with results of several authors [2, 6, 11, 12]. According to Zaujec et al. [16] and Friedel et al. [3] the main reason could be more favourable chemical and elements composition of oil rape crop residues. Tested bio-stimulators influenced the increase of basal respiration, but their influence was more marked in variants with crop residues of winter wheat. The highest values of basal respiration were observed in Ch+WR+B after 7 days of incubation, where the amount of evolved CO_2 was by 203% more than control (Ch+WR). From tested bio-stimulators, BETA-LIQ had more marked influence on production of CO_2, but without statistical significance (table 2). The values of basal respiration decreased by increasing incubation time (figure 1).

The effect of bio-stimulators was higher also in the end of incubation in variants with crop residues of winter wheat. The values of potential respiration with adding nitrogen (N), glucose (G) and glucose together with nitrogen (NG) were determined as well (figure 2). The incubation time and applied crop residues had statistically significant influence on values of potential respiration (table 2). Since added N marked by influenced activity of soil organisms, the potential respiration with adding N was higher than basal, what confirmed [4]. During incubation, higher potential respiration with adding N was observed in variants with crop residues of oil rape than winter wheat. In initial phase of incubation BETA-LIQ had more marked effect on CO_2 production, and in the end of incubation TRICHOMIL. The highest activity soil microorganisms after adding of G and NG was determined after 7 days of incubation (figures 3 and 4). The highest production of

orb. 2. Dynamika potenciálnej (N) respirácie počas inkubácie
fig. 2. Dynamic of potential (N) respiration during incubation



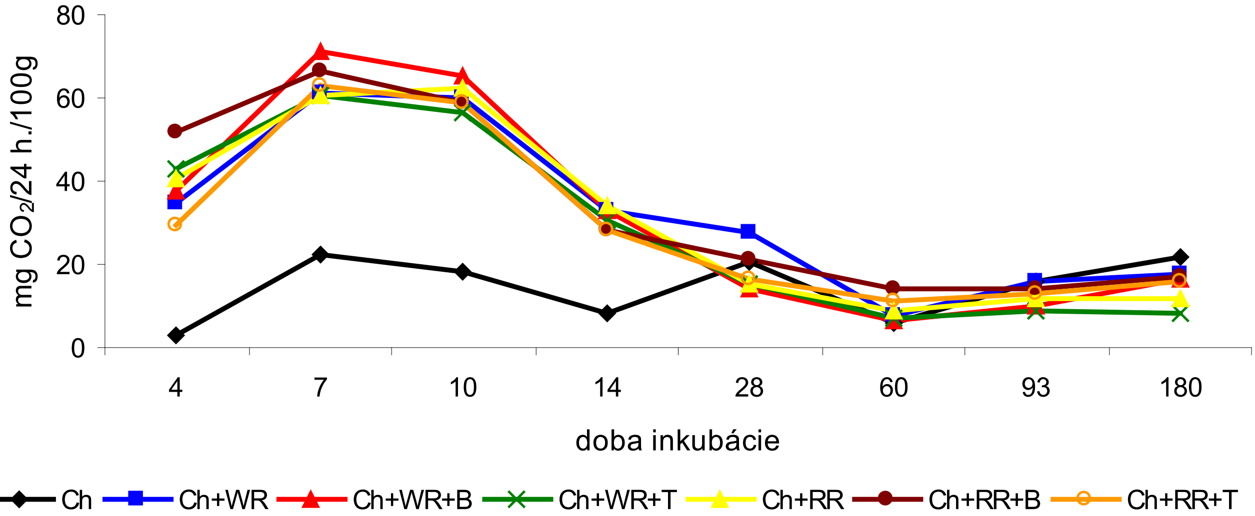
obr. 3. Dynamika potenciálnej (G) respirácie počas inkubácie
fig. 3. Dynamic of potential (G) respiration during incubation



CO_2 was observed in variant Ch+WR+B with adding NG (70.94 mg CO_2/24 h./100g). Tested BETA-LIQ also increased production of CO_2 by adding G in variants with crop residues of oil rape (70.75 mg CO_2/24 h./100g). Exponential functions were calculated for values of potential respiration (table 1), because is presented by Brady and Weil [2], exponential functions the best express the dynamics of CO_2 change. The crop residues of winter wheat more influenced the decrease of potential respiration with adding N and G than crop residues of oil rape, what is in agreement with Šimanský and Zaujec [10]. Tested TRICHOMIL more influenced the dynamic of potential respiration (added N, G, NG) and CO_2 production than BETA-LIQ, but only in variants with crop residues of winter wheat (table 1).

The incubation time and applied crop residues had statistically significant influence on values of relative respiration (table 2). Calculated values of relative respiration are presented in tables 3-6. Applied crop residues and bio-stimulators induced decreasing of nitrogen utilization in soil. The crop residues of winter wheat and TRICHOMIL more influenced decrease of nitrogen utilization than crop residues of oil rape and tested BETA-LIQ (table 3). Amount of easy-utilized organic substances decreased by the incubation time. In variants with crop residues of winter wheat were determined higher amount of more easy-utilized organic substances than in variants with crop residues of oil rape, what depends on chemical and elements composition of used crop residues [15]. Higher amount of more easy-utilized organic substances was found in variants with BETA-LIQ than TRICHOMIL (table 4).

obr. 4. Dynamika potenciálnej (NG) respirácie počas inkubácie
fig. 4. Dynamic of potential (NG) respiration during incubation



Carbon and nitrogen utilization in soil was determined on the basis of potential respiration with adding glucose to nitrogen ratio (G:N). In respiration process the carbon from easy-utilized carbon source (glucose) was more used than nitrogen by the incubation time in all variants (table 5). The crop residues of oil rape (11.43) more marked by effected utilization of carbon than crop residues of winter wheat (10.47), and from bio-stimulators the utilization was higher in variants with BETA-LIQ (12.42) than TRICHOMIL (10.57). On the basis of NG:B ratio the stability of organic substances was evaluated [16]. The tendency of increase the organic substances stability was observed in variants with added crop residues, and also tested bio-stimulators, (table 6). More marked effect on stability of organic substances had the crop residues of oil rape and from a bio-stimulators the BETA-LIQ, what is in agreement with Tobiašová et. al. [14].

Conclusion

The incubation time and applied crop residues had statistically significant influence on basal, potential and relative respiration. The crop residues of oil rape more effected increase of basal and potential respiration as compared to crop residues of winter wheat. Crop residues of oil rape more affected the stability of organic substances as compared to crop residues of winter wheat. Crop residues of winter wheat more marked by effected decreasing of nitrogen utilization. A higher amount of easy-utilized organic substances was found in variants with applied crop residues of winter wheat as well.

Tested bio-stimulators induced the increase of basal respiration, but their effect was more marked in variants with crop residues of winter wheat. The effect of bio-stimulators was very intensive in the end of incubation in variants with crop residues of winter wheat. From tested bio-stimulators more marked effect on basal and potential respiration had BETA-LIQ. More easy-utilized organic substances were observed in variant with BETA-LIQ as well as BETA-LIQ more effected utilization of carbon and stability of organic substances as compared to TRICHOMIL. The crop residues of winter wheat had higher effect on the changes in decrease of potential respiration dynamics than crop residues of oil rape.

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References

[1] Alef K., Nannipieri P., Methods in applied soil microbiology and biochemistry, Academic Prass, London 1995.

[2] Brady C.N., Weil R.R., The nature and properties of soils. Prentice-Hall, New Jersey, 1999.

[3] Friedel J.K., Munch J.C., Fischer W.R., Soil microbial properties and the assessment of available soil organic mater in a Haplic Luvisol after several yaers of different cultivation and crop rotation, Soil Biol. Biochem. (1996) 28: 479 – 488.

[4] Horník A., Respiračná aktivita hnedozemných pôd a čierníc Podunajskej nížiny, Acta Fytotechnica. (1990): 47-65.

[5] Novák B., Aphelthaler R., Příspěvek k metodice stanovení respirace jako indikátoru mikrobiologických pochodů v půde, Rostlinná výroba (1964) 10: 145-148.

[6] Pascual J.A., Hernandez T., Garcia C., Ayusot M., Carbon Mineralization in an Arid Soil Amended with Organic Wastes of Varying Degerees of Stability, Commun. Soil. Sci. Plant Anal.(1998) 29: 835-846.

[7] Popelárová E., Voříšek K., Strnadová S., Mineralization activity in soils for the development of the precision farming system, Arch. Acker Pfl. Boden (2002) 48: 147-153.

[8] Schinner F., Őhlinger R., Kandeler E., Margesin R., Methods in Soil Biology, Berlin, 1995.

[9] Šantrůčková H., Mikrobní biomasa jako ukazovatel biologické aktivity půdy, Rostlinná výroba (1993) 9: 779-788.

[10] Šimanský V., Zaujec A., Changes in total carbon contents and its forms after application of crop residues and bio-stimulators in Haplic Chernozems, Humic substances in ecosystems 7 (Abstracts), Bachotek : NCU, 2007, p. 31.

[11] Šimanský V., Zaujec A., Tobiašová E., Vplyv biostimulátora Beta-Liq na transformačné procesy pozberových zvyškov pšenice letnej formy ozimnej a kapusty repkovej pravej, Biotechnology 2006, České Budějovice, Scientific Pedagogical Publishing, 2006, pp. 1053-1055.

[12] Šimanský V., Zaujec A., Tobiašová E., Vplyv biostimulátora Trichomil na transformačné procesy, Biotechnology 2006, České Budějovice, Scientific Pedagogical Publishing, 2006, pp. 1050-1052.

[13] Števlíková T., Vjatráková J., Dobošová B., Vrchovský J., Vplyv hnojenia dusíkom a biostimulátorov na vybrané parametre biologickej aktivity pôdy, Agrochémia (1999) 4: 4-8.

[14] Tobiašová E., Zaujec A., Šimanský V., Influence of biostimulators on decomposition of wheat and rape residues, Humic Substances in Ecosystems 5, Bydgoczcz, UTA, 2003, pp. 127-132.

[15] Zaujec A., Jurčová O., The chemical composition of selected plant residues, Humic substances as factor of terrestrial and aquatic ecosystem,. Bydgoszcz, UTA, 1999, p 45.

[16] Zaujec A., Šimanský V., Vplyv biostimulátorov rozkladu rastlinných zvyškov na pôdnu štruktúru a organickú hmotu pôdy, Nitra, 2006.

Tabuľka 1 Zmeny poklesu potenciálnej (N, G, NG) respirácie počas inkubácie
Table 1 Potential respiration (N, G, NG) during incubation

variant	Exponential models production of CO_2 by adding N	R^2	production of CO_2 by adding G	R^2	production of CO_2 by adding NG	R^2
Ch	$y = 0.82e^{-0.13x}$	0.367	$y = 6.70e^{-0.06x}$	0.096	$y = 6.79e^{0.12x}$	0.153
Ch+WR	$y = 11.89e^{-0.42x}$	0.900	$y = 100.33e^{-0.42x}$	0.826	$y = 69.23e^{-0.21x}$	0.547
Ch+WR+B	$y = 16.25e^{-0.46x}$	0.934	$y = 104.04e^{-0.37x}$	0.839	$y = 81.14e^{-0.28x}$	0.611
Ch+WR+T	$y = 11.44e^{-0.39x}$	0.953	$y = 102.48e^{-0.37x}$	0.845	$y = 94.54e^{-0.34x}$	0.832
Ch+RR	$y = 19.43e^{-0.48x}$	0.927	$y = 109.5e^{-0.37x}$	0.832	$y = 83.32e^{-0.28x}$	0.755
Ch+RR +B	$y = 20.54e^{-0.48x}$	0.911	$y = 96.98e^{-0.32x}$	0.683	$y = 82.44e^{-0.24x}$	0.813
Ch+RR +T	$y = 19.76e^{-0.47x}$	0.931	$y = 79.02e^{-0.32x}$	0.639	$y = 62.45e^{-0.21x}$	0.608

Ch –černozem, Ch+WR –černozem + pšenica letná forma ozimná, Ch+WR+B - černozem + pšenica letná forma ozimná + BETA-LIQ, Ch+WR+T - černozem + pšenica letná forma ozimná + TRICHOMIL, Ch+RR – černozem + kapusta repková pravá, Ch+ RR+B - černozem + kapusta repková pravá + BETA-LIQ, Ch+RR+T - černozem + kapusta repková pravá + TRICHOMIL

Ch –Haplic Chernozems, Ch+WR – Haplic Chernozems + winter wheat, Ch+WR+B - Haplic Chernozems + winter wheat + BETA-LIQ, Ch+WR+T - Haplic Chernozems + winter wheat + TRICHOMIL, Ch+RR – Haplic Chernozems + oil rape, Ch+ RR+B - Haplic Chernozems + oil rape + BETA-LIQ, Ch+RR+T - Haplic Chernozems + oil rape + TRICHOMIL

Tabuľka 2 Štatistické vyhodnotenie bazálnej, potenciálnej a relatívnej respirácie – LSD multiple range test
Table 2 Statistical evaluation of basal, potential and relative respiration – LSD multiple-range test

	B	N	G	NG	N:B	G:B	G:N	NG:B	$\frac{NG:G}{N:B}$
IT									
4	7.96d	7.89d	36.81c	30.89d	1.41a	9.87a	5.89a	23.48a	0.75ab
7	3.44c	4.76c	52.77d	54.64e	1.87abc	19.81a	10.84ab	36.27a	0.76ab
10	3.31c	3.97c	39.56c	50.98e	1.90abc	20.47a	10.72ab	45.56a	0.91ab
14	2.10bc	2.02b	26.74b	24.62cd	1.63ab	18.06a	12.13b	33.67a	0.84ab
28	0.89ab	0.90ab	5.59a	15.48bc	1.73ab	18.82a	8.89ab	54.05a	1.64c
60	0.35a	0.71ab	2.18a	5.52a	2.56c	20.86a	6.37ab	44.92a	0.82ab
93	0.25a	0.48ab	3.47a	9.50ab	2.24bc	21.50a	8.44ab	61.96a	1.27bc
180	0.35a	0.20a	4.02a	12.26ab	3.63d	94.69b	29.67c	221.03b	0.57a
CR									
Co_{CR}	0.52a	0.76a	6.87a	14.14a	3.46c	42.97b	12.21a	133.48b	0.64a
WR	2.88b	3.02b	27.13b	30.88b	1.45a	17.65a	10.47a	29.50a	1.15b
RR	3.32b	3.92c	30.17b	31.44b	1.46a	23.41a	12,17a	32.38a	1.04ab
Bios.									
Co_{B}	1.96a	2.33a	20.19a	25.79a	2.26a	30.13a	11.28a	73.04a	1.11a
B	2.13a	2.83a	23.57a	27.18a	1.98a	26.80a	12.72a	61.19a	0.89a
T	2.64a	2.54a	20.41a	23.49a	2.12a	27.09a	10.87a	61.12a	0.83a

Rozdielne písmená (a, b, c, d) poukazujú na preukaznosť na hladine významnosti P<0.05 podľa LSD multiple-range test
B – bazálna respirácia, N, G, NG – potenciálna respirácia, N:B, G:B, G:N, NG:B, $\frac{NG:G}{N:B}$ *- relatívna respirácia, IT – doba inkubácie,* C_{oCR} *– kontorla bez pozberových zvyškov, WR – pozberové zvyšky pšenice letnej formy ozimnej, RR – pozberové zvyšky kapusty repkovej pravej,* C_{oB} *– kontrola bez biostimulátorov, B – BETA-LIQ, T – TRICHOMIL*
Different letters (a, b, c, d) indicate that treatment means are significantly different at P<0.05 according to LSD multiple-range test
B – basal respiration, N, G, NG – potential respiration, N:B, G:B, G:N, NG:B, $\frac{NG:G}{N:B}$ *- relative respiration, IT – incubation time,* C_{oCR} *– control without crop residues, WR – crop residues of winter wheat, RR – crop residues of oil rape,* C_{oB} *- control without bio-stimulators, B – BETA-LIQ, T - TRICHOMIL*

Tabuľka 3 Priemerné hodnoty relatívnej respirácie (N:B) počas inkubácie
Table 3 Average values of relative respiration (N:B) during incubation

	4	7	10	14	28	60	93	180
Ch	1.30	1.34	3.86	3.09	3.33	5.82	5.11	4.94
CR	1.01	1.54	1.15	0.95	1.04	1.60	1.34	2.98
WR	0.82	1.82	1.03	0.96	1.05	1.82	1.32	2.80
RR	1.20	1.26	1.28	0.97	1.02	1.37	1.37	3.17
Bio-st.	0.99	1.30	1.16	0.98	1.14	1.41	1.29	2.80
B	0.93	1.17	1.19	1.06	1.06	1.26	1.42	2.40
T	1.05	1.43	1.13	0.90	1.23	1.57	1.16	3.20

Ch -černozem, CR -pozberové zvyšky, WR -zvyšky pšenice letnej formy ozimnej, RR -zvyšky kapusty repkovej pravej, Bio-st. -biostimulátory, B-BETA-LIQ, T-TRICHOMIL
Ch -Haplic Luvisols, CR -crop residues, WR -crop residues of winter wheat, RR -crop residues of oil rape, Bio-st. -biopreparates, B-BETA-LIQ, T-TRICHOMIL

Tabuľka 4 Priemerné hodnoty relatívnej respirácie (G:B) počas inkubácie
Table 4 Average values of relative respiration (G:B) during incubation

	4	7	10	14	28	60	93	180
Ch	11.44	11.21	47.00	27.23	59.78	66.98	61.31	75.80
CR	4.97	16.60	11.42	11.90	7.36	8.54	10.23	93.21
WR	4.92	19.22	11.61	11.28	9.81	11.51	5.90	66.94
RR	5.02	13.99	11.23	12.52	4.91	5.56	14.55	119.47
Bio-st.	4.57	13.96	11.40	12.28	8.55	7.24	12.22	85.52
B	4.33	12.68	11.77	12.85	8.48	7.24	13.96	83.29
T	4.81	15.23	11.02	11.72	8.63	7.24	10.49	87.75

Ch -černozem, CR -pozberové zvyšky, WR -zvyšky pšenice letnej formy ozimnej, RR -zvyšky kapusty repkovej pravej, Bio-st. -biostimulátory, B-BETA-LIQ, T-TRICHOMIL
Ch -Haplic Luvisols, CR -crop residues, WR -crop residues of winter wheat, RR -crop residues of oil rape, Bio-st. -biopreparates, B-BETA-LIQ, T-TRICHOMIL

Tabuľka 5 Priemerné hodnoty relatívnej respirácie (G:N) počas inkubácie
Table 5 Average values of relative respiration (G:N) during incubation

	4	7	10	14	28	60	93	180
Ch	8.77	8.37	12.18	8.81	17.95	11.52	12.01	15.35
CR	5.16	10.99	10.22	12.43	7.13	5.26	7.59	31.80
WR	6.18	10.59	11.57	11.82	9.31	6.49	4.72	23.07
RR	4.14	11.40	8.87	13.04	4.95	4.02	10.46	40.53
Bio-st.	4.65	10.96	10.32	12.68	7.69	5.04	9.14	31.48
B	4.71	11.07	9.91	12.20	8.56	5.49	9.34	38.09
T	4.60	10.85	10.73	13.16	6.83	4.60	8.93	24.88

Ch -černozem, CR -pozberové zvyšky, WR -zvyšky pšenice letnej formy ozimnej, RR -zvyšky kapusty repkovej pravej, Bio-st. -biostimulátory, B-BETA-LIQ, T-TRICHOMIL
Ch -Haplic Luvisols, CR -crop residues, WR -crop residues of winter wheat, RR -crop residues of oil rape, Bio-st. -biopreparates, B-BETA-LIQ, T-TRICHOMIL

Tabuľka 6 Priemerné hodnoty relatívnej respirácie (NG:B) počas inkubácie
Table 6 Average values of relative respiration (NG:B) during incubation

	4	7	10	14	28	60	93	180
Ch	10.52	24.37	106.06	42.89	173.19	119.51	208.29	446.35
CR	4.17	16.79	14.01	10.66	12.73	11.02	16.10	157.01
WR	4.26	19.95	14.80	11.48	15.55	12.66	14.90	132.37
RR	4.08	13.62	13.22	9.84	9.91	9.38	17.30	181.65
Bio-st.	4.00	14.11	13.20	10.25	13.32	9.82	14.73	128.89
B	3.73	12.85	13.84	10.41	13.49	9.06	16.90	135.81
T	4.26	15.36	12.55	10.09	13.16	10.58	12.57	121.98

Ch -černozem, CR -pozberové zvyšky, WR -zvyšky pšenice letnej formy ozimnej, RR -zvyšky kapusty repkovej pravej, Bio-st. -biostimulátory, B-BETA-LIQ, T-TRICHOMIL
Ch -Haplic Luvisols, CR -crop residues, WR -crop residues of winter wheat, RR -crop residues of oil rape, Bio-st. -biopreparates, B-BETA-LIQ, T-TRICHOMIL