Coll. Antropol. **38** (2014) Suppl. 1: 77–83
Original scientific paper

The Influence of Agroclimatic Factors on Soil CO_2 Emissions

Darija Bilandžija, Željka Zgorelec and Ivica Kisić

University of Zagreb, Faculty of Agriculture, Department of General Agronomy, Zagreb, Croatia

A B S T R A C T

There has been a significant increase of atmospheric greenhouse gas (GHG) concentrations since industrial revolution till nowadays. Approximately 10% of total GHG emissions in Croatia belong to the agricultural sector. In this sector, one part of CO_2 is released from soil by soil respiration (soil CO_2 efflux). Due to these facts, it is of scientists' interest to determine the influence of tillage treatments on soil CO_2 efflux and to determine a relationship between tillage induced CO_2 emissions and climatic factors. Field experiment with six different tillage treatments was set up on Stagnic Luvisols near Daruvar (central lowland Croatia). Tillage treatments were: black fallow (BF), ploughing up and down the slope to 30 cm (PUDS), no – tillage (NT), ploughing up and down slope to 30 cm (PAS), very deep ploughing across the slope to 50 cm (VDPAS) and subsoiling across the slope to 50 cm (SSPAS). Soil CO_2 efflux was measured using closed static chamber method to quantify soil CO_2 efflux during 2012 (n=13) when cover crop was corn. Tillage had a significant effect on CO_2 efflux. The lowest average CO_2 efflux was determined at the BF treatment with the average CO_2 efflux of 29.4 kg ha^{-1} day^{-1}. Comparing the treatments with the cover crop, the highest average CO_2 efflux was determined at the NT treatment followed by SSPAS, VDPAS, PAS and PUDS treatment with the average CO_2 efflux of 90.9 kg ha^{-1} day^{-1}, 83.5 kg ha^{-1} day^{-1}, 68.9 kg ha^{-1} day^{-1}, 66.7 kg ha^{-1} day^{-1}, 56.0 kg ha^{-1} day^{-1} respectively. Average CO_2 effluxes were moderate positively correlated with soil temperatures at 10 cm depth (r=0.42), moderate positively correlated with air temperature (r=0.45), and non correlated with soil moisture content at 10 cm depth (r=0.08), while strong negatively correlated with relative air humidity (r=0.55). The CO_2 efflux was higher during the second half of spring and in the first half of summer while lower CO_2 efflux was determined during the period autumn – winter CO_2 effluxes were higher in first half of corn growing season than in the second half of corn growing season and the period without the cover crop. Our study suggests that tillage practices have significant influence on soil CO_2 emissions.

***Key words**: CO_2 efflux, agricultural soil, soil temperature, soil moisture, air temperature, relative air humidity, soil tillage*

Introduction

Climate change is one of the greatest challenges that the world is facing today. Since the industrial revolution till nowadays, there has been a significant increase of atmospheric greenhouse gas (GHG) concentrations. The impact of climate change is obvious in all parts of the world as well as in the Croatia. In the Republic of Croatia, the period 1991–2000 was the warmest decade of the 20th century and it is predicted that average temperatures in 2025 will increase by maximum of 1 °C in winter, summer and autumn, while spring temperatures will remain the same[1]. To reduce the global GHG emissions, Kyoto protocol has been adopted in Kyoto in 1997 and Republic of Croatia has ratified the Kyoto protocol in 2007. According to Kyoto protocol, countries have to report on their GHG emissions from six sectors and one of them is agricultural sector. Approximately 10% of total GHG emissions in Croatia belong to the agricultural sector according to experts' estimates.

Among GHGs, carbon dioxide (CO_2) is one of the most significant contributors to regional and global warming. One part of CO_2 is released from soil in the process of soil respiration. Soil respiration or soil CO_2 efflux is one of the most important components of the ecosystem carbon budget, which consists of organic matter decomposition and mineralization, root respiration and rhizosphere or

Received for publication November 29, 2013

faunal respiration[2]. Soil–plant system and the pedosphere-atmosphere interface are sites of intense carbon exchange with 10% of atmospheric carbon passing through soils annually[3]. Moreover, soil contains twice the amount of carbon as the atmosphere and it is therefore an important component of the global carbon budget[4,5].

Studies have shown that factors such as soil temperature, soil moisture content, tillage systems, irrigation practices, presence of organic matter and nutrients, soil aeration, microbial processes and soil diffusivity influence the CO_2 production and emission rates from the soil surface[4]. Tillage and soil disturbance strongly affect CO_2 emission by creating soil conditions favourable for oxidation and mineralization of organic C in the soil[6]. Tillage accelerates soil CO_2 emission by improving soil aeration, soil disaggregation and increasing the contact between soil and crop residue[7]. Also, land management practices can influence soil temperature and moisture content[8] which can directly affect CO_2 effluxes from the soil surface[9,10]. Soil temperature and soil moisture content are the characteristics that most commonly impact temporal variation in CO_2 efflux from soils. An increase in soil temperature accelerates organic matter decomposition, oxidation, microbial and root activity, and C mineralization processes. This acceleration thereby increases CO_2 emission from the soil[6] and thus the soil temperature is an important factor in controlling major processes in the C cycle. Soil moisture content is another important factor affecting biological respiration and soil CO_2 evolution. Soil moisture also affects CO_2 production and distribution through its influence on gas diffusion and microbial activity[11]. Therefore, measuring soil CO_2 efflux is crucial to accurately evaluate the effect of soil management practices on global warming and carbon cycling. Although many studies on soil CO_2 emissions are conducted around the world, the lack of research and scientific data on the soil CO_2 emissions in the Republic of Croatia has motivate us to begin the research on the influence of agroclimatic factors on soil CO_2 emissions.

Material and Methods

Experimental site and tillage treatments

Field experiment with six different tillage treatments usually implemented in Croatia was set up in Blagorodovac near Daruvar (elevation: 133 m asl; N 45° 33' 937", E 17° 02' 056") in central, lowland Croatia. Field experiment was establish in 1994 with the aim of investigation on determination of soil degradation by water erosion and later, in 2011, expanded to the research on soil CO_2 concentration measurements. Soil type at the experimental site is determined as Stagnic Luvisols[12]. Tillage treatments differed in tools that were used, depth and direction of tillage and planting. Size of each tillage treatment is 22.1 m × 1.87 m. Tillage treatments were:

1. BF: black fallow, control treatment – ploughing direction is up and down the slope;
2. PUDS: ploughing to 30 cm – ploughing and planting direction is up and down the slope, disked and harrowed;
3. NT: no-tillage – planting in conducted directly into the mulch with planting direction up and down the slope;
4. PAS: ploughing to 30 cm – ploughing and planting direction is across the slope, disked and harrowed;
5. VDPAS: very deep ploughing to 50 cm – ploughing and planting direction is across the slope, disked and harrowed;
6. SSPAS: ploughing to 30 cm plus subsoiling to 50 cm – ploughing, subsoiling and planting direction is across the slope, disked and harrowed.

Research period, climate conditions and cover crop at the experimental site

The measurements of soil CO_2 concentrations and agroclimatic conditions were conducted during the year 2012 (n=13), approximately once per month. All measurements were conducted in three repetitions what makes the total number of 234 measurements for each parameter (13 measurement dates × 3 repetitions × 6 treatments).

For the interpretation of climate conditions in the climatological period 1961–1990 and studied 2012 at the experimental site, the official meteorological data from the main meteorological station of Meteorological and Hydrological Service of Croatia located in Daruvar were used. The climate conditions at the experimental site are described by Lang's rain factor and Walter climate diagram. Lang's rain factor represents the ratio of mean annual precipitation amount (mm) and mean annual temperature (°C). The climate classification for the interpretation of Lang's rain factor is conducted according to Gračanin's climate classification[13].

Cover crop at the experimental field was corn (*Zea mays L.* – hybrid Zlatko.), the main arable crop (34.2% of total arable land and gardens area) in Croatia[14]. At the experimental field, corn was seeded on 30 April 2012 and harvest was conducted on 1 October 2012. Depth of sowing was 3-4 cm, distance between rows was 70 cm and inter-row distance was 22 cm, what makes the total number of 65,000 plants per hectare.

Measurement of agroclimatic factors

The aim of the research requires the reliable data on the weather conditions, especially on air temperature and relative air humidity. Therefore, at the beginning and the end (about 3 hours later) of each measurement date, the air temperature (°C) and relative air humidity (%) were determined with the adequate instrument (Testo 511, 2011) at the height about 1 m above the soil surface. The research aim also requires the data on the soil temperature and soil moisture in the upper soil layer (at 10 cm depth). Soil temperature (°C) and soil moisture (%) were determined with adequate instrument (IMKO HD2 – probe Trime, Pico64, 2011) at the 10 cm depth in the vicinity of the chambers on each measurement date.

Measurement of CO_2 concentrations

For the measurement of soil carbon dioxide concentrations, the closed static chamber method was used. The chambers are made of lightproof metal material to avoid the sunlight effect on the measurements, and they consist of two parts: frames and caps. The circular frames (25 cm in diameter) are inserted between the growing plants about 5 cm into the soil at the beginning of measurements. The caps are 25 cm in diameter and 9 cm high, fitted with a gas sampling port. Before the chambers closure, the initial CO_2 concentrations inside the frames near soil surface were measured. Afterwards, the chambers were closed with caps and the incubation period was 30 minutes after which the CO_2 concentrations in closed static chambers were measured. In situ measurements of carbon dioxide concentrations (ppm) in the chambers were conducted with portable infrared carbon dioxide detector (GasAlertMicro5 IR, 2011). Measurements were conducted on bare soil and when necessary (at the no-tillage treatment), vegetation was removed from frames inside before the beginning of measurement.

Measurements of carbon dioxide concentrations were conducted in three repetitions at each treatment. The soil carbon dioxide efflux (expressed as kg CO_2 per ha per day) was afterwards calculated according to authors[15,16] as:

$$F_{CO2} = [M \times P \times V \times (c_2 - c_1)] / [R \times T \times A \times (t_2 - t_1)]$$

Where:

- F_{CO2} – soil CO_2 efflux (kg ha^{-1} day^{-1})
- M – molar mass of the CO_2 (kg mol^{-1})
- P – air pressure (Pa)
- V – chamber volume (m^3)
- $c_2 - c_1$ – CO_2 concentration increase rate in the chamber during incubation period (μmol mol^{-1})
- R – gas constant (J mol^{-1} K^{-1})
- T – air temperature (K)
- A – chamber surface (m^2)
- $t_2 - t_1$ – incubation period (day)

Data analysis

Soil CO_2 efflux, soil temperature, soil moisture, air temperature and relative air humidity were analyzed using SAS according to the GLM procedure in the SAS system package version 8.00[17]. A linear regression procedure was used to determine the dependence of each air and soil property on soil surface CO_2 efflux. The interpretation of correlation coefficients was conducted according[18].

Results and Discussion

Climate conditions at the experimental site

The experimental field is characterised by continental climate. In the largest part of central lowland Croatia there is a prevalent humid climate[19]. Mean annual amount of precipitation in Daruvar during referent 30-year period (1961–1990) was 878 mm and mean annual temperature was 10.6 °C. According to the Lang's rain factor (L_f), the 30-year period (1961–1990) was characterised by the humid climate (L_f=83). The year 2012 was dryer and warmer compared to referent period with mean annual precipitation amount of 789 mm and mean annual temperature of 11.8 °C. According to the Lang's rain factor, the year 2012 was characterised by semihumid climate (L_f=67). In 2012 March and August were drier, and September and December wetter in relation to the reference period (Figure 1). During 2012, summer months June, July and August as well as November were warmer and February colder than the referent period (Figure 2).

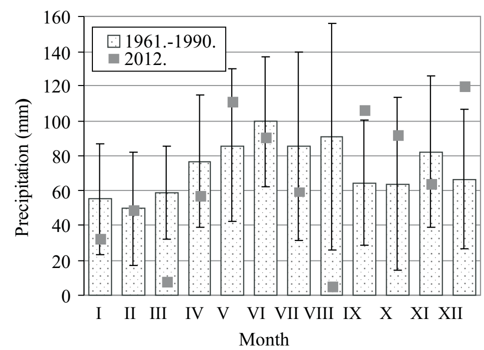

Fig. 1. Mean monthly amount of precipitation (columns) and intervals [R+sd, R–sd] (stocks) during 1961–1990 and precipitation amounts for 2012 (squares).

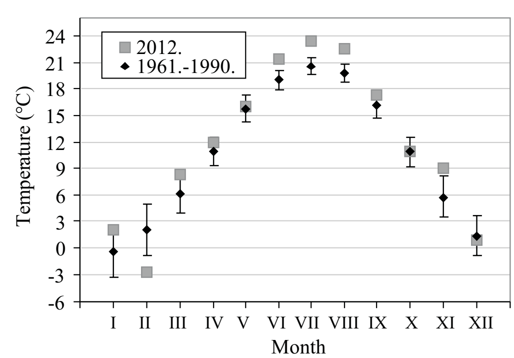

Fig. 2. Mean monthly air temperature (rombs) and intervals [t+sd, t–sd] (stocks) for 1961–1990 and air temperature during 2012 (squares).

Average climate conditions are without dry period during the 30-year period (1961–1990) according to Walter climate diagram (Figure 3) while in the studied year 2012 there was determined a water deficit in March, July and August (Figure 4).

Agroclimatic factors and CO_2 efflux

Tillage had a significant effect on CO_2 efflux (Table 1). The same conclusions were obtained by other authors[6]. The lowest average CO_2 efflux was determined at the BF treatment with the average CO_2 efflux of 29.4 kg ha^{-1}

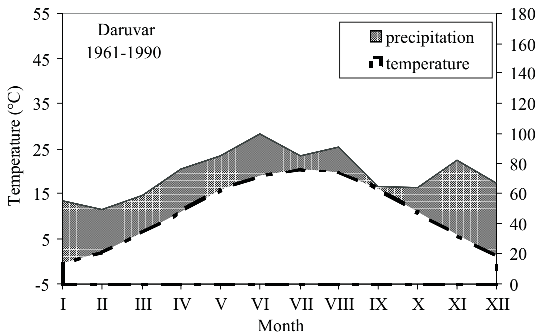

Fig. 3. Walter climate diagram: 1961–1990.

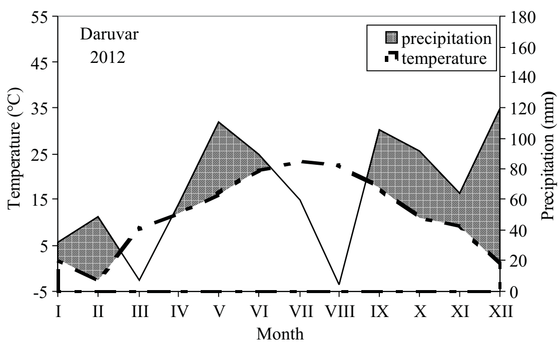

Fig. 4. Walter climate diagram: 2012.

day^{-1}. This data are in accordance with the literature sources that stated that the presence of crops have influence on CO_2 emissions and these emission from soil are approximately 2 to 3 times higher in cropped soil compared to bare soil[20]. If we compare the treatments with the cover crop, the highest average CO_2 efflux was determined at the NT treatment followed by SSPAS, VDPAS, PAS and PUDS treatment with the average CO_2 effluxes of 90.9 kg ha^{-1} day^{-1}, 83.5 kg ha^{-1} day^{-1}, 68.9 kg ha^{-1} day^{-1}, 66.7 kg ha^{-1} day^{-1}, 56.0 kg ha^{-1} day^{-1} respectively. The higher CO_2 emissions under NT could be attributed to maintenance of higher soil water content at the soil surface and higher biological activity. A review of the literature indicates a contradictory results regard to tillage effects on CO_2 emissions. The greater average CO_2 fluxes were determined under no tillage than under conventional tillage[21,22] while, in contrast, lower CO_2 emissions were observed under no tillage compared to conventional tillage[7,8,23,24].

TABLE 1
EFFECT OF TILLAGE TREATMENTS ON AVERAGE SOIL CO_2 EFFLUX AND AVERAGE SOIL PROPERTIES

Tillage treatment	CO_2 efflux (kg ha^{-1} day^{-1})	Soil temperature (°C)	Soil moisture (%)
BF	29.4d	23.7	24.4
PUDS	56.0c	23.5	23.2
NT	90.9a	25.3	24.9
PAS	66.7bc	25.3	22.1
VDPAS	68.9abc	26.1	22.0
SSPAS	83.5ab	25.8	22.0
LSD	22.4	4.2	4.7
p	$<0.0001^{***}$	NS	NS

On the measurement dates at the experimental site, the mean (n=13) air temperature was 26.4 °C and mean relative air humidity was 42%. The average soil temperatures differ by maximum of 2.6 °C (Table 1). The highest average soil temperature was determined under VDPAS and the lowest one under the PUDS treatment. Average soil temperatures at the treatments were lower than mean air temperature during the studied period. Furthermore, average soil moisture contents differ by maximum of 2.9% (Table 1). The highest average soil moisture content was determined under NT and the lowest one under the SSPAS treatment which may be attributed to the presence of crop residues on the soil surface under NT which minimizes the losses due to evaporation and surface runoff.

The treatment with the highest average CO_2 efflux variation during the investigated period was NT, followed by SSPAS, VDPAS, PAS, PUDS and BF where CO_2 efflux range amounted 212.6 kg ha^{-1} day^{-1}, 208.3 kg ha^{-1} day^{-1}, 147.0 kg ha^{-1} day^{-1}, 135.5 kg ha^{-1} day^{-1}, 119.9 kg ha^{-1} day^{-1} and 74.2 kg ha^{-1} day^{-1} respectively (Table 2).

The highest variation of soil temperature was determined at the VDPAS followed by NT, SSPAS, PAS, BF, PUDS with soil temperature range of 39.2 °C, 36.8 °C, 35.0 °C, 34.1 °C, 32.7 °C and 29.9 °C respectively (Table

TABLE 2
VARIATIONS OF CO_2 EFFLUX, SOIL TEMPERATURE AND SOIL MOISTURE DURING 2012

Treatment	CO_2 efflux (kg ha^{-1} day^{-1})			Soil temperature (°C)			Soil moisture (%)		
	minimum	maximum	range	minimum	maximum	range	minimum	maximum	range
BF	8.6	82.8	74.2	3.4	36.1	32.7	8.5	38.3	29.8
PUDS	8.6	128.4	119.9	3.4	33.5	29.9	8.6	39.2	30.7
NT	28.5	241.1	212.6	3.0	39.7	36.8	8.1	36.7	28.6
PAS	11.4	147.0	135.5	3.1	37.2	34.1	8.1	34.0	25.8
VDPAS	17.1	164.1	147.0	3.2	42.4	39.2	8.6	32.2	23.6
SSPAS	14.3	222.6	208.3	3.6	38.6	35.0	7.8	37.0	29.2

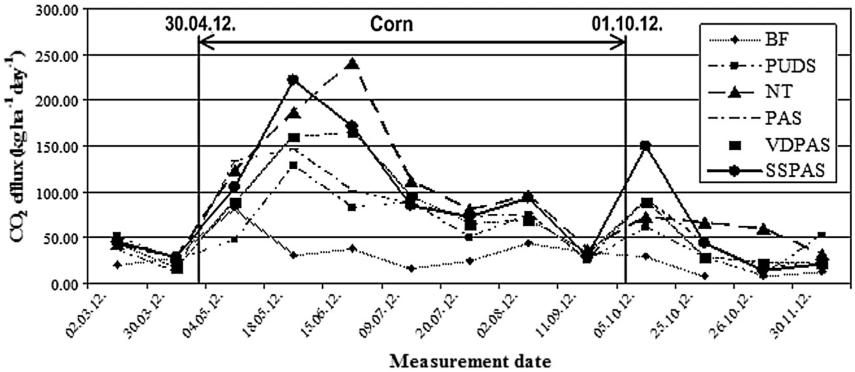

Fig. 5. CO_2 effluxes during the investigated period.

2). The treatment with the highest variation of soil moisture content during the investigated period was PUDS followed by BF, SSPAS, NT, PAS and VDPAS with soil moisture range of 30.7%, 29.8%, 29.2%, 28.6%, 25.8% and 23.6% respectively (Table 2).

The CO_2 efflux was higher during the second half of spring and in the first half of summer while lower CO_2 efflux was determined during period autumn-winter (Figure 5). Higher CO_2 emissions were determined during the summer period and the lowest one in autumn period by other authors[25]. Effluxes of carbon dioxide were related to crop growth. CO_2 effluxes were higher in first half of corn growing season and lower in the second half of corn growing season and period without the cover crop what was likely a result of considerable contributions from root and microbial respiration. Other authors[26] also determined that CO_2 efflux from soil is closely correlated to plant growth. Higher effluxes determined shortly after the harvest were most likely related to crop root and residue decomposition.

Relationships between CO_2 efflux, air and soil properties

Correlation between CO_2 efflux, air and soil properties are presented at Figures 6–9. Average CO_2 effluxes were moderate positively correlated with soil temperatures at 10 cm depth (r=0.42), moderate positively correlated with air temperature (r=0.45), and non correlated with soil moisture content at 10 cm depth (r=0.08), while strong negatively correlated with relative air humidity

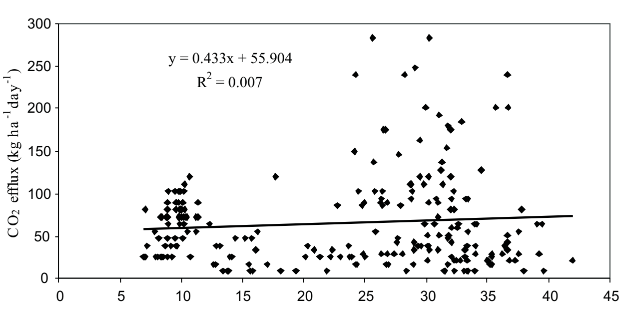

Fig. 6. Correlation between CO_2 efflux and soil moisture at 10 cm depth.

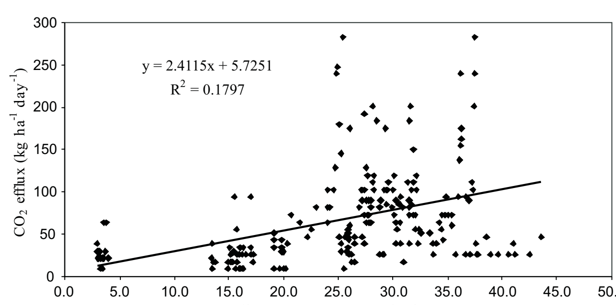

Fig. 7. Correlation between CO_2 efflux and soil temperature at 10 cm depth.

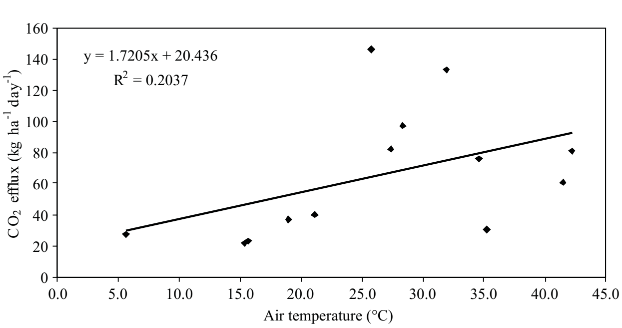

Fig. 8. Correlation between CO_2 efflux and air temperature.

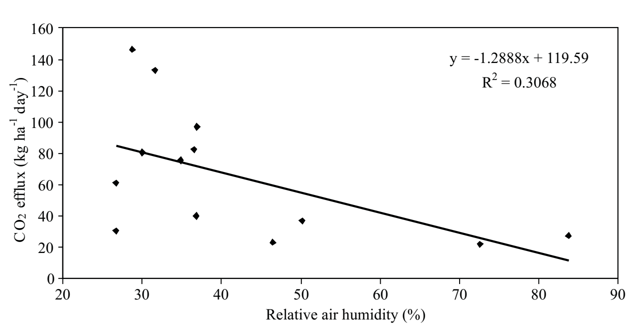

Fig. 9. Correlation between CO_2 efflux and relative air humidity.

(r=0.55). These results are suggesting an increase of CO_2 efflux with increase of soil temperature what is attributed to higher soil biological activity. In another study it was determined that CO_2 fluxes were positively correlated with air temperatures (r=0.88) and soil temperatures in the top 20 cm (r=0.87) and negatively with soil water content (r=0.75)[24]. Other authors have also reported positive correlation between CO_2 fluxes and soil temperature[6,7,27,28]. An increase of CO_2 effluxes with the increase of soil moisture content can be attributed to the fact that sufficient soil moisture content stimulates microbial activity and enhances root respiration, thereby increasing CO_2 emission from the soil surface. A direct linear relationship was determined between volumetric soil moisture content and CO_2 efflux[6] while authors[29] concluded that CO_2 emissions are primarily depended on temperature, but becomes moisture dependent as soil dries.

Conclusions

This research was initiated to assess the CO_2 effluxes on Stagnic Luvisols that has been managed using BF, PUDS, NT, PAS, VDPAS and SSPAS practices for 16 years. The experimental field is characterised by continental climate. The studied 2012 year was dryer and warmer compared to 30-year period (1961–1990) with mean annual precipitation amount of 789 mm and mean annual temperature of 11.8 °C. In 2012, water deficit in March, July and August was determined.

Tillage had a significant effect on CO_2 efflux. The lowest average CO_2 efflux was determined at the BF treatment with the average CO_2 efflux of 29.4 kg ha^{-1} day^{-1}. Comparing the treatments with the cover crop, the highest average CO_2 efflux was determined at the NT treatment followed by SSPAS, VDPAS, PAS and PUDS treatment with the average CO_2 efflux of 90.9 kg ha^{-1} day^{-1}, 83.5 kg ha^{-1} day^{-1}, 68.9 kg ha^{-1} day^{-1}, 66.7 kg ha^{-1} day^{-1}, 56.0 kg ha^{-1} day^{-1} respectively.

At the time of measurements, mean (n=13) air temperature was 26.4 °C and mean relative air humidity was 42% at the experimental site. The average soil temperatures differ by maximum of 2.6 °C. Average soil temperatures at the treatments were lower than mean air temperature during the studied period. Furthermore, average soil moisture content differs by maximum of 2.9%.

The treatment with the highest variation of CO_2 efflux during the investigated period was NT (212.6 kg ha^{-1} day^{-1}) and the treatment with the lowest variation of CO_2 efflux was BF (74.2 kg ha^{-1} day^{-1}). The highest variation of soil temperature was determined at VDPAS (39.2 °C) treatment and the lowest one was determined at PUDS (29.9 °C) treatment. The treatment with the highest variation of soil moisture content was PUDS (30.6%) and the treatment with the lowest variation of soil moisture content was VDPAS (23.6%).

The CO_2 efflux was higher during the second half of spring and in the first half of summer while lower CO_2 efflux was determined during period autumn-winter. CO_2 effluxes were depended on crop growth and they were higher in the first half of corn growing season and lower in the second half of corn growing season and the period without the cover crop.

Average CO_2 effluxes were moderate positively correlated with soil temperatures at 10 cm depth (r=0.42), moderate positively correlated with air temperature (r= 0.45), and non correlated with soil moisture content at 10 cm depth (r=0.08), while strong negatively correlated with relative air humidity (r=0.55). Our study suggests that tillage practices have a significant influence on soil CO_2 emissions.

REFERENCES

1. BRANKOVIĆ Č, BRAY J, CALLAWAY J, DULČIĆ J, GAJIĆ-ČAPKA M, GLAMUZINA B, HEIM I, JAPEC L, KALINSKI V, LANDAU S, LEGRO S, OIKON ORTL F, PATARČIĆ M, SRNEC L, ŠIMLEŠA D, ZANINOVIĆ K, ZNAOR D, A Climate for Change, Climate change and its impacts on society and economy in Croatia (United Nations Development Programme (UNDP) in Croatia, Zagreb, 2009). — 2. CARLISLE EA, STEENWERTH KL, SMART DR, J Environ Qual, 35 (2006) 1396. — 3. RAICH JW, TUFEKCIOGLU A, Biogeochemistry, 48 (2000) 71. — 4. MIELNICK PC, DUGAS WA, Soil Biol Biochem, 32 (1999) 221. — 5. MAIER CA, KRESS LW, Can J Forest Res, 30 (2000) 347. — 6. JABRO JD, SAINJU U, STEVENS WB, EVANS RG, J Environ Manage, 88 (2008) 1478. — 7. AL-KAISI MM, YIN X, J Environ Qual, 34 (2005) 437. — 8. CURTIN D, WANG H, SELLES F, MCCONKEY BG, CAMPBELL CA, Soil Sci Soc Am J, 64 (2000) 2080. — 9. PARKIN TB, KASPAR TC, Soil Sci Soc Am J, 67 (2003) 1763. — 10. AMOS B, ARKEBAUER TJ, DORAN JW, Soil Sci Soc Am J, 69 (2005) 387. — 11. LOU Y, LI Z, ZHANG T, Water Air Soil Pollut, 149 (2003) 281. — 12. World reference base for soil resources 2006, A framework for international classification, correlation and communication (Food and agriculture organization of the United Nations, Rome, 2006). — 13. BUTORAC A, Opća proizvodnja bilja-praktikum (Faculty of Agriculture University of Zagreb, Zagreb, 1988). — 14. Statistical Yearbook of the Republic of Croatia 2012 (Croatian Bureau of Statistics, Zagreb, 2012). — 15. WIDEN B, LINDROTH A, Soil Sci Soc Am J, 67 (2003) 327. — 16. TOTH T, FORIZS I, KUTI L, Cereal Res Commun, 33 (2005) 133. — 17. SAS Institute, Inc. SAS User's Guide: Statisties (SAS Institute, 2000). — 18. VASILJ Đ, Biometrika i eksperimentiranje u bilinogojstvu (Hrvatsko agronomsko društvo, Zagreb, 2000) — 19. GAJIĆ-ČAPKA M, ZANINOVIĆ K, Climate of Croatia, In: ZANINOVIĆ K, (Ed) Climate atlas of Croatia 1961–1990., 1971–2000. (Meteorological and Hydrological Service of Croatia, Zagreb, 2008). — 20. RASTOGI M, SINGH S, PATHAK H, Curr Sci, 82 (2002) 510. — 21. HENDRIX PF, HAN CR, GROFFMAN PM, Soil Till Res, 12 (1988) 135. — 22. FRANZLUEBBERS AJ, HONS FM, ZUBERER DA, Soil Till Res, 34 (1995) 41. — 23. BAUER PJ, FREDERICK JR, NOVAK JM, HUNT PG, Soil Till Res, 90 (2006) 205. — 24. USSIRI DAN, LAL R, Soil Till Res, 104 (2009) 39. — 25. JACINTHE PA, LAL R, KIMBLE JM, Soil Till Res, 67 (2002) 147. — 26. SCHLESINGER WH, ANDREWS JA, Biogeochemistry, 48 (2000) 7. — 27. DUIKER SW, LAL R, Soil Till Res, 54 (2000) 21. — 28. SAVAGE KE, DAVIDSON EA, J Exp Bot, 54 (2003) 891. — 29. SMITH KA, BALL T, CONEN F, DOBBIE KE, MASSHEDER J, REY A, Eur J Soil Sci, 54 (2003) 779.

D. Bilandžija

Faculty of Agriculture, University of Zagreb, Svetošimunska 25, 10 000 Zagreb, Croatia
e-mail: dbilandzija@agr.hr

UTJECAJ AGROKLIMATSKIH ČIMBENIKA NA EMISIJU CO_2 IZ TLA

S A Ž E T A K

Od početka industrijske revolucije do danas, značajno se povećala koncentracija stakleničkih plinova u atmosferi. Približno 10% od ukupnih emisija stakleničkih plinova u RH pripada sektoru poljoprivrede. U tom sektoru, dio CO_2 se otpušta iz tla putem disanja tla (CO_2 fluks iz tla). Temeljem navedenog, znanstvenicima je od interesa utvrditi utjecaj načina obrade tla na fluks CO_2 iz poljoprivrednih tala te utvrditi odnos između obradom uzrokovanih emisija CO_2 i klimatskih čimbenika. Pokusno polje sa šest različitih načina obrade tla postavljeno je na pseudogleju distričnom kod Daruvara (središnja nizinska Hrvatska). Načini obrade tla su: crni ugar (BF), oranje do 30 cm uz i niz nagib (PUDS), izostavljena obrada (NT), oranje do 30 cm okomito na nagib (PAS), vrlo duboko oranje do 50 cm okomito na nagib (VDPAS) te podrivanje do 50 cm okomito na nagib (SSPAS). CO_2 fluks iz tla se mjerio metodom zatvorenih statičkih komora tijekom 2012 (n=13) kada je pokrovni usjev bio kukuruz. Načini obrade su imali značajan utjecaj na CO_2 fluks iz tla. Najniži prosječan CO_2 fluks je utvrđen na varijanti BF gdje je prosječan CO_2 fluks iznosio 29,4 kg ha^{-1} day^{-1}. Usporedivši varijante sa usjevom, najviši prosječan CO_2 fluks je utvrđen na varijanti NT (90,9 kg ha^{-1} day^{-1}) nakon koje su slijedile varijante SSPAS (83,5 kg ha^{-1} day^{-1}), VDPAS (68,9 kg ha^{-1} day^{-1}), PAS (66,7 kg ha^{-1} day^{-1}) i PUDS (56,0 kg ha^{-1} day^{-1}). Prosječni CO_2 fluksevi su prema jačini korelacije bili srednje pozitivno korelirani sa temperaturama tla na 10 cm dubine (r=0,42), srednje pozitivno korelirani sa temperaturama zraka (r=0,45), sa vlagom tla na 10 cm dubine nije utvrđena korelacija (r=0,08) dok je utvrđena jaka negativna korelacija sa relativnom vlažnošću zraka (r=0,55). CO_2 fluks je bio viši tijekom druge polovice proljeća i u prvoj polovici ljeta dok je niži CO_2 fluks utvrđen tijekom perioda jesen – zima. Također, CO_2 fluks je bio viši tijekom prve polovice vegetacijskog perioda kukuruza u odnosu na drugu polovicu vegetacijskog perioda kukuruza i perioda bez usjeva. Naše istraživanje upućuje da su načini obrade tla imali značaj utjecaj na emisiju CO_2 iz tla te da je temperatura tla bila glavni faktor utjecaja na CO_2 emisiju iz tla.