
Soil carbon loss by soil respiration under different tillage treatments

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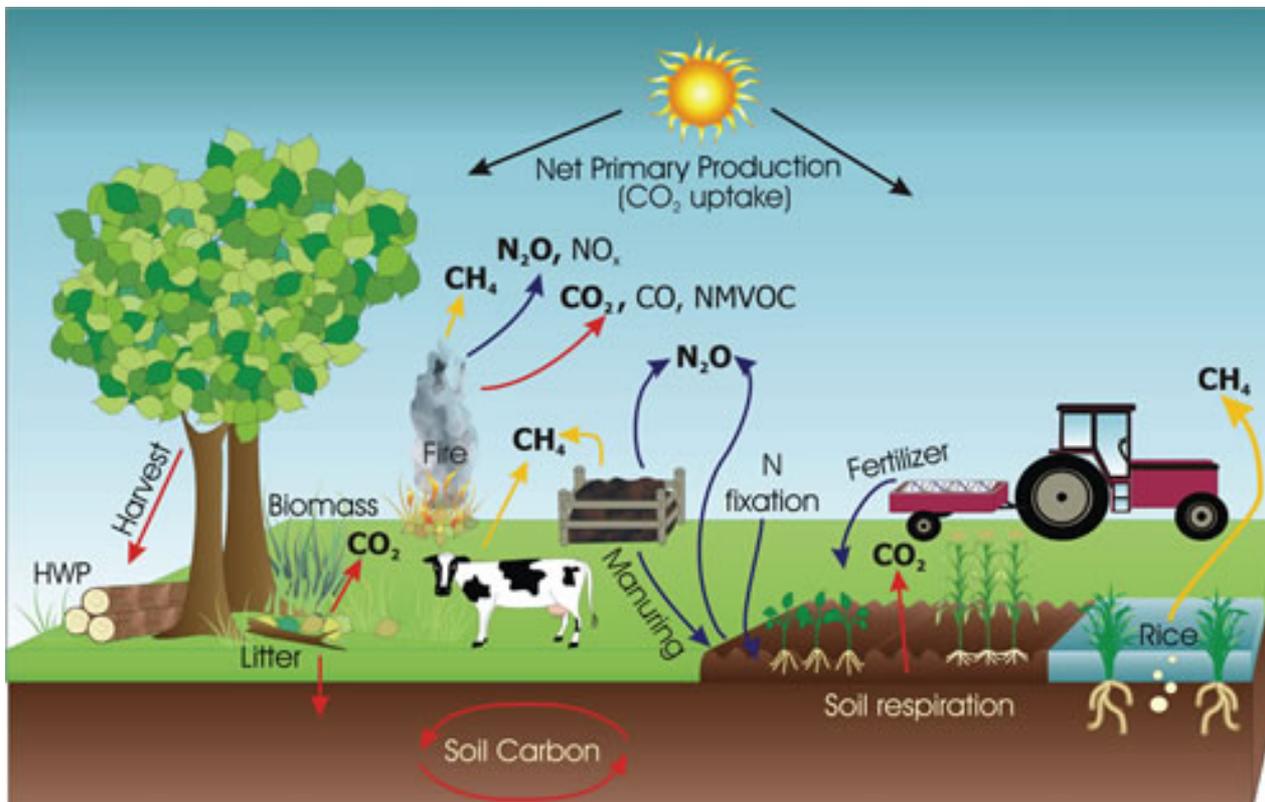
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It is presumed that increased concentrations of GHG emissions cause the global warming which is obvious in all parts of the world as well as in the Republic of Croatia.

The period 1991-2000 was the warmest decade of the 20th century in Croatia



Human activities (such as tillage) have impact on soil carbon stocks and can decrease them significantly.



Sources and sinks of GHG emissions in agriculture, forests, and other land use systems ([IPCC 2006](#))



Aim of the research

Aim of the research was to determined:

- soil total carbon content in the soil surface layer (0-30 cm),
- the variations of CO₂-C efflux during the year,
- soil carbon loss by CO₂-C efflux,
- correlation between soil total carbon content and CO₂-C efflux.



Google Earth, 2013

Location of the experimental site is situated near Daruvar in central lowland Croatia (N 45°33'937'', E 17°02'056'')



Soil type:
Stagnic Luvisols



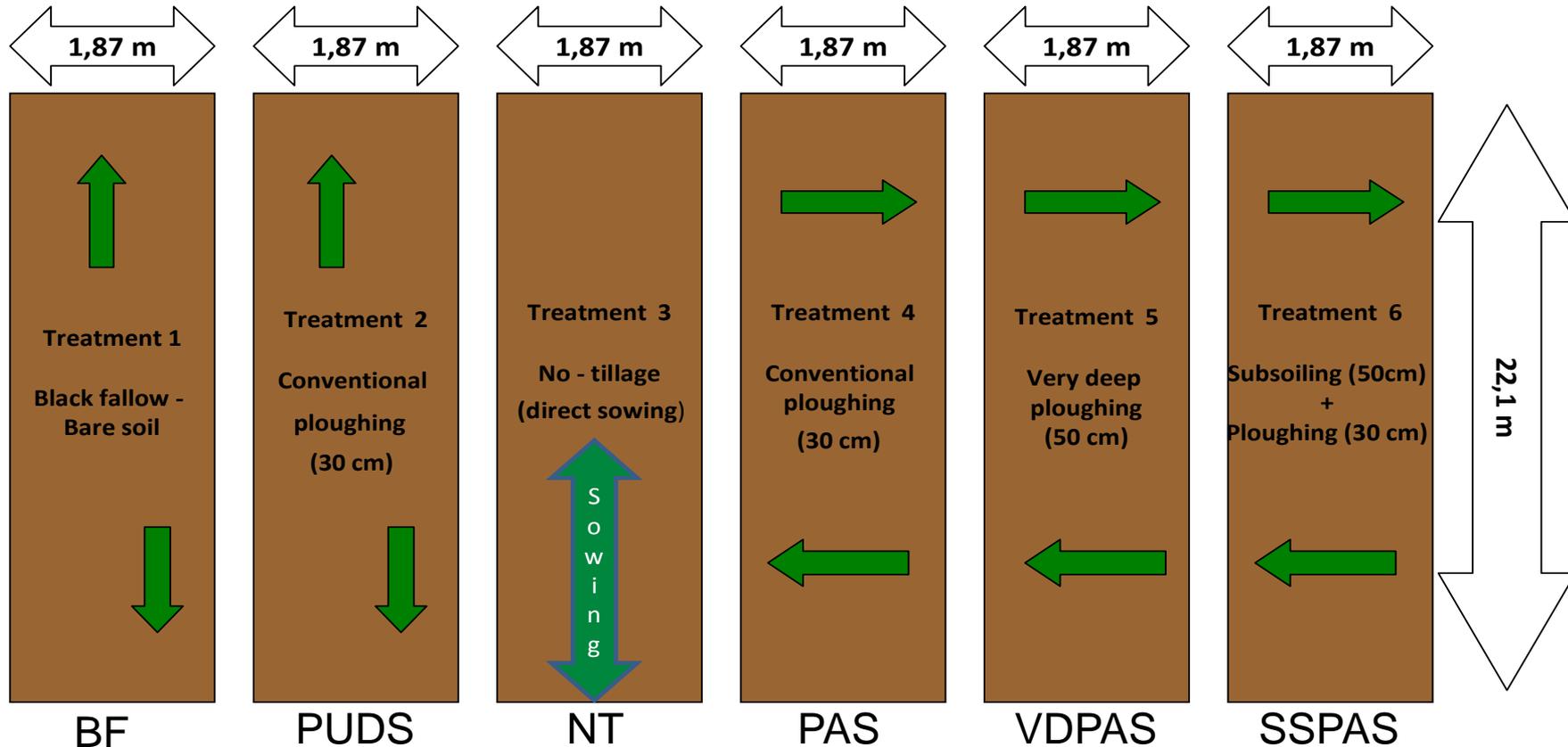
1. “Conservation management of soils exposed to water erosion”
(Ministry of Science, Education and Sports of RC)

Leader: Full Professor Ivica Kisić, PhD

2. „Influence of different land management on climate change”
(Environmental protection and energy efficiency Fund)

Leader: Assistant Professor Željka Zgorelec, PhD

Tillage treatments differed in tools that were used, depth and direction of tillage and planting



Field measurements of soil CO₂ concentrations were conducted during one year (n=14), from November 2011 – November 2012.

Cover crop at the experimental field was corn (*Zea mays L.*), hybrid Zlatko, the main arable crop in Croatia.

Corn was seeded on 30. April 2012:

distance between rows: 70 cm

inter-row distance: 22 cm

depth of sowing: 3-4 cm

Harvest was conducted on 1. October 2012

Preliminary soil sampling was conducted in April 2011.

Samples were sampled with the soil probe (Eijkelkamp, 2005).

The soil total carbon content was determined in the composite soil sample which were composed of 10 individual soil samples on each treatment



Preparation of soil samples (ISO 11464:2006) and determination of soil total carbon content (ISO 10694:1995) was conducted in the Analytical Laboratory of Department of General Agronomy, Faculty of Agriculture.

For the measurement of soil carbon dioxide concentrations (ppm), the closed static chamber method was used.

Chamber construction:

Faculty of Agriculture, Zagreb
Tukač private company



Soil CO₂ concentrations were measured with detector of carbon dioxide
GasAlertMicro5 IR



Materials and methods

Measurements of CO₂ emissions from agricultural soil



CO₂ efflux was afterwards calculated according to Widen and Lindroth (2003) and Toth et al. (2005) as:

$$F_{\text{CO}_2} = [M * P * V * (c_2 - c_1)] / [R * T * A * (t_2 - t_1)]$$

F_{CO_2} – soil CO₂ flux (kg/ha/day)

M – molar mass of the CO₂ (kg mol⁻¹)

P – air pressure (Pa)

V – chamber volume (m³)

c_1 – initial concentration of CO₂ (μmol mol⁻¹)

c_2 – concentration of CO₂ after incubation time (μmol mol⁻¹)

R - gass constant (J mol⁻¹ K⁻¹)

T – air temperature (K)

A – chamber surface (m²)

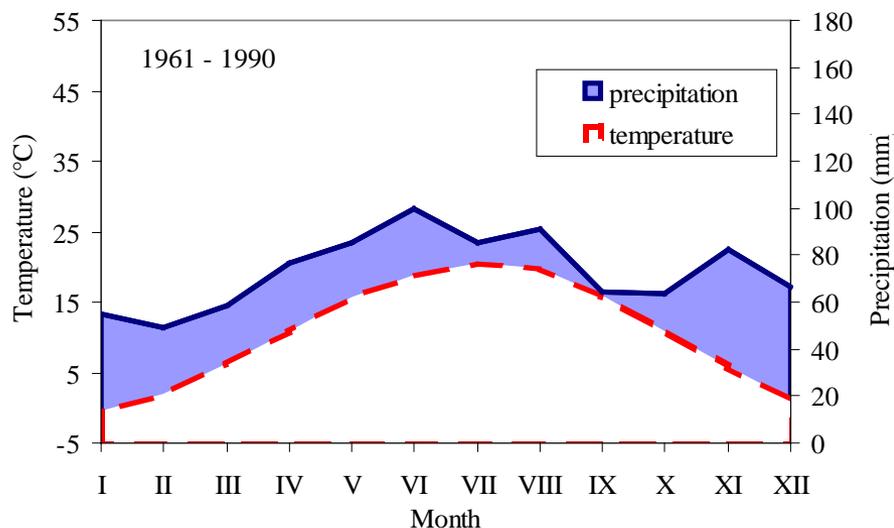
$t_2 - t_1$ – incubation period (day)

The experimental site is characterised by continental climate.

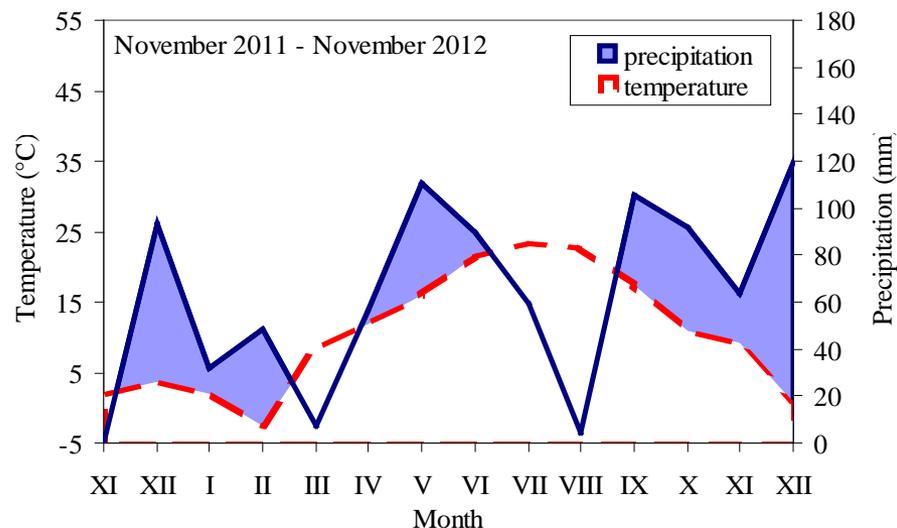
Period	Precipitation (mm)	Temperature (°C)	Lang's rain factor
1961-1990	878	10,6	83 (h)
November 2011- November 2012	763	11,2	68 (sh)

Meteorological data: Meteorological and Hydrological Service of Croatia – main meteorological station located in Daruvar

Walter climate diagram for the period 1961 - 1990

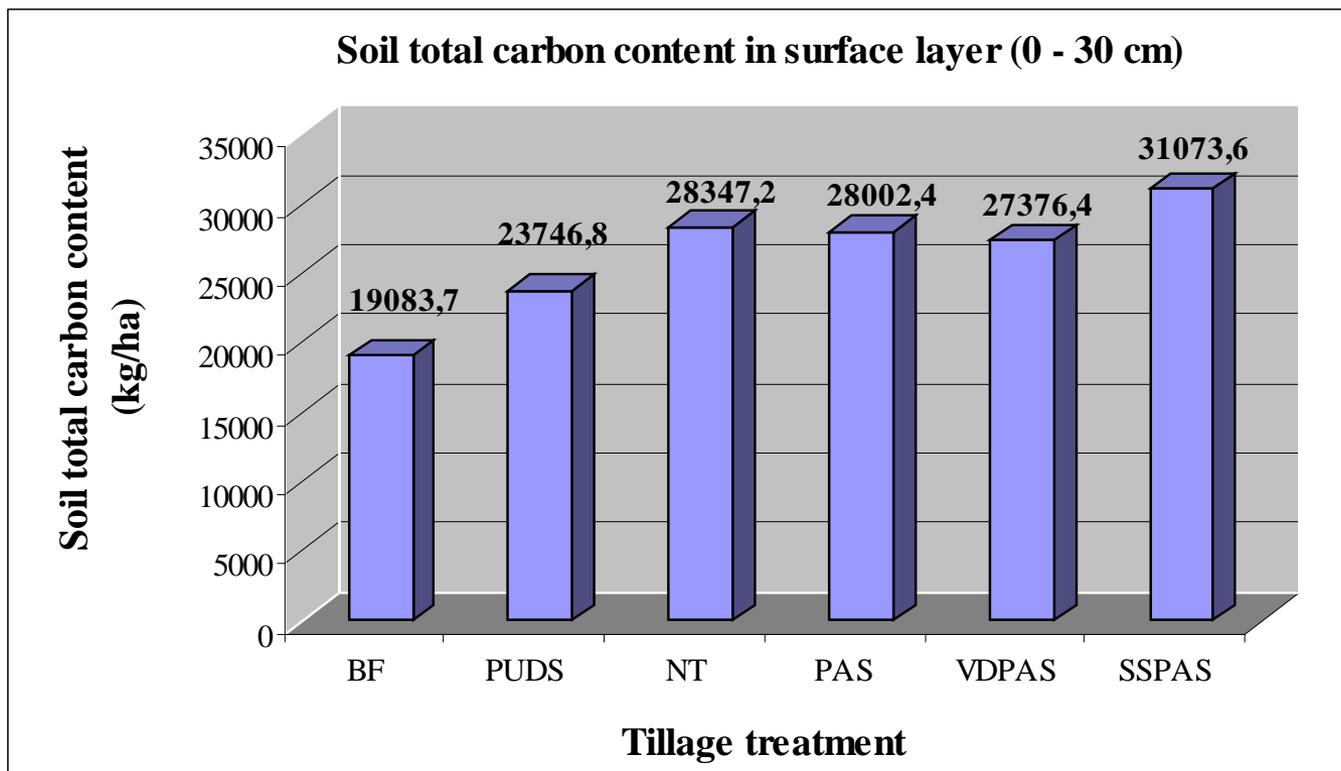


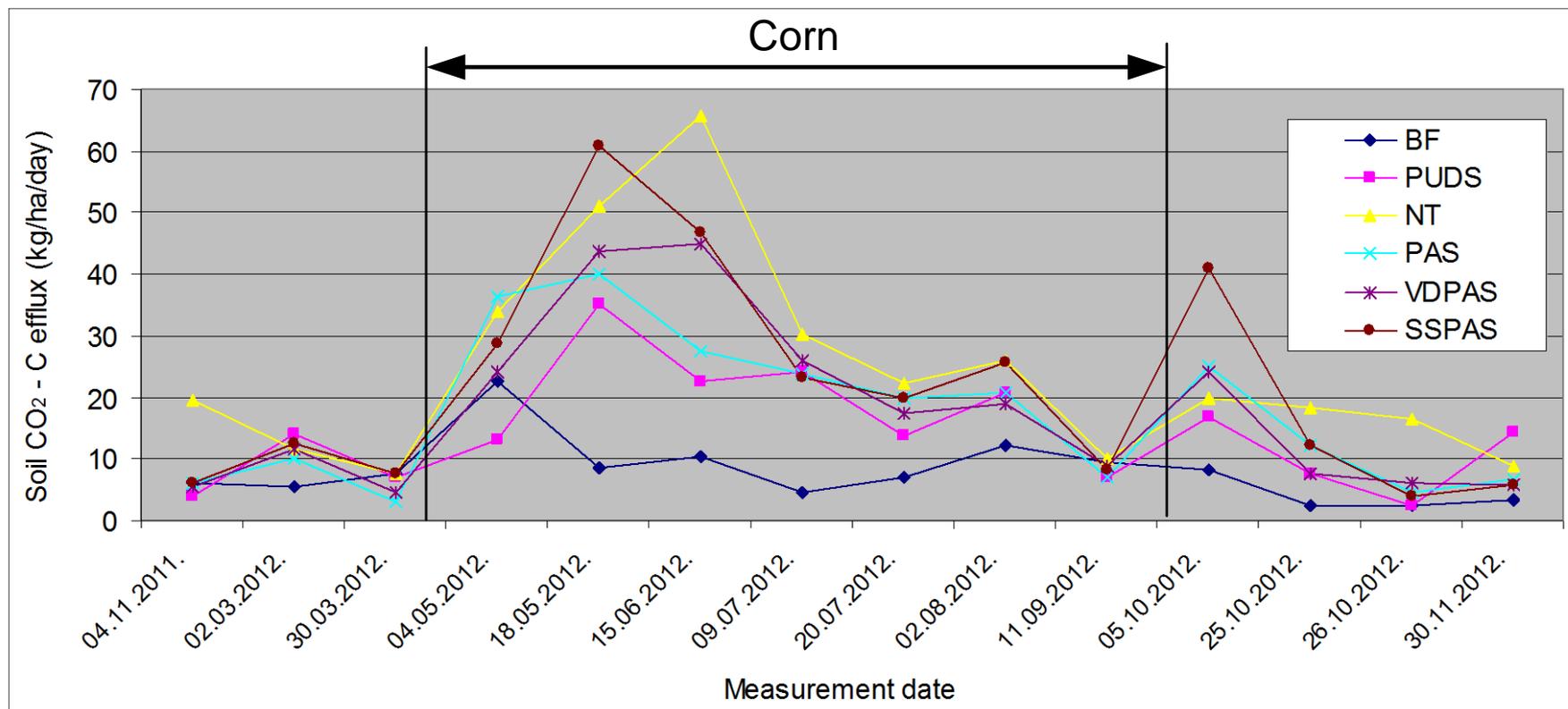
Walter climate diagram for the period November 2011 – November 2012



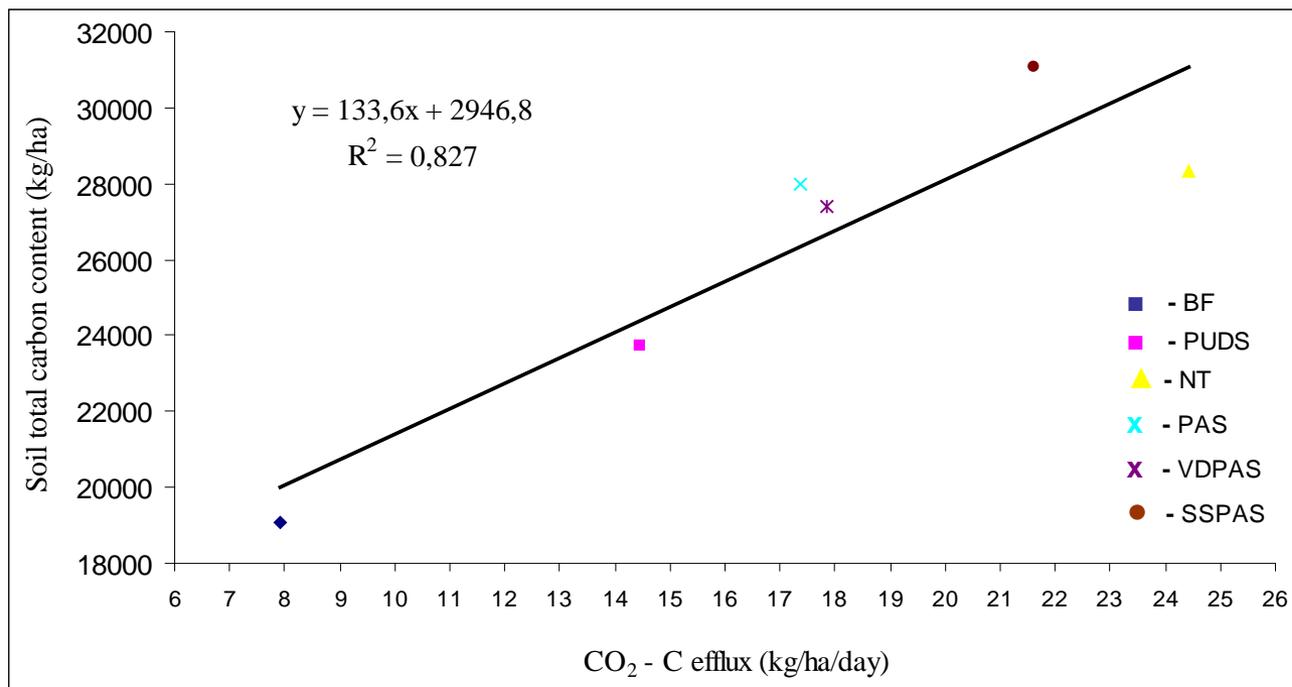
Soil total carbon content in the surface layer (0 - 30 cm)

Soil total carbon content differed by maximal of 11 989,9 kg/ha between the tillage treatments in the soil surface layer (0 - 30 cm).





Minimal, maximal and average CO ₂ – C efflux (kg ha ⁻¹ day ⁻¹) in investigated period				
Tillage treatment	Minimal CO ₂ – C efflux (kg ha ⁻¹ day ⁻¹)	Maximal CO ₂ – C efflux (kg ha ⁻¹ day ⁻¹)	Range (kg ha ⁻¹ day ⁻¹)	Average CO ₂ – C efflux (kg ha ⁻¹ day ⁻¹)
BF	2,3	22,6	20,3	7,9
PUDS	2,3	35,1	32,7	14,5
NT	7,8	65,8	58,0	24,4
PAS	3,1	40,1	37,0	17,4
VDPAS	4,7	44,8	40,1	17,9
SSPAS	3,9	60,8	56,9	21,6



CO₂ - C efflux was fully positively correlated with soil total carbon content ($r = 0,91$).

Tillage treatment	Soil total carbon content kg/ha	Average CO ₂ – C efflux (kg ha ⁻¹ day ⁻¹)	Daily C loss (%)
BF	19083,7	7,9	0,04
PUDS	23746,8	14,5	0,06
NT	28347,2	24,4	0,09
PAS	28002,4	17,4	0,06
VDPAS	27376,4	17,9	0,07
SSPAS	31073,6	21,6	0,07

1. The lowest soil total carbon content was determined at BF treatment while the highest one at SSPAS treatment
3. The treatment with the lowest average CO₂-C efflux was BF and with the highest one NT
3. Daily soil total carbon loss by soil respiration ranged from 0,04% at BF treatment up to 0,09% at NT treatment
4. Soil CO₂-C efflux was fully positively correlated with soil total carbon content ($r=0,91$).
5. Although the lowest soil C loss by soil respiration and CO₂ - C efflux were determined at treatment with black fallow (BF), this treatment can not be recommended as it serves as the control treatment
6. After all mentioned, it can be said that in these agro-ecological conditions, best tillage practice in sustainable plant production in terms of the lowest daily soil total carbon loss (0,06%) by soil respiration is ploughing to 30 cm (PUDS and PAS).
7. Still, it is necessary to conduct the total soil carbon balance in the future research for better understanding of soil carbon gains and losses.

Thank you for your attention



Hvala na pažnji

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