The dynamic of Planosol chemical composition and CO2 respiration in differently tilled faba bean cultivation

VYTAUTAS MAGNUS UNIVERSITY AGRICULTURE ACADEMY

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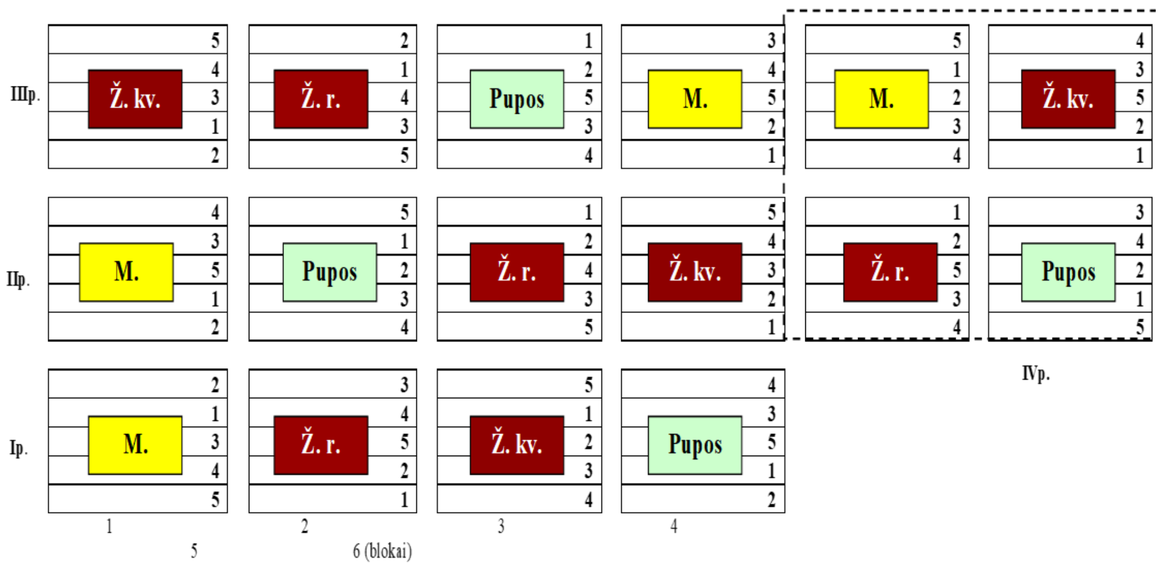
The aim of this study was to establish the influence of five tillage systems on the chemical composition, temperature, moisture content, and soil respiration during faba bean vegetation.

Materials and methods

Field experiment was carried out in 2016-2018, the investigations on the basis of a long-term stationary field experiment (since 1988) was carried out at the Experimental Station of Vytautas Magnus University, Agriculture Academy (VDU ZUA, 54º52 N, 23º49 E), Lithuania. Five different tillage systems were tested: 1) conventional (22-25 cm) ploughing with a mouldboard plough (control), 2) shallow (12-15 cm) ploughing with a mouldboard plough, 3) deep (22-25 cm) chiseling, 4) shallow (10-12 cm) disking and 5) no-tillage. The experiment was performed in 4 replications. There were 20 plots per crop in total. The initial size of the experimental plot was 126 m^2 (14x9 m) (Figures 1-2).

Randomized design of plot's distribution was used. Experiment buffer boundary – 1 m wide and 9 m wide between blokes. After crop harvesting, all experimental plots (except NT) were disked with a Väderstad Carrier 300 disc harrow. Crop rotation: winter oilseed rape, winter wheat, faba bean, spring barley.



Future 1. Design of experiment

Figure 2. General view of experiment

Results

Table 1. The effect of the tillage systems on the soil chemical composition (0–15 cm soil layer).

Tillage System	Timing	Soil Chemical Composition				
		pH$_{HCl}$, mol l^{-1}	P_2O_5, mg kg^{-1}	K_2O, mg kg^{-1}	Mg, mg kg^{-1}	N_{total}, %
2016						
Deep ploughing	BS	7.1	231	85	360	0.131
	AH	7.4	237	104	437	0.129
Shallow ploughing	BS	7.0	248	108*	347	0.143
	AH	7.4	257	122	434	0.139
Deep cultivation-chiselling	BS	7.4	250	120**	446	0.142
	AH	7.3	194	101	346	0.130
Shallow cultivation-disking	BS	7.1	284	149**	408	0.144
	AH	7.1	284	138*	324	0.144
No-tillage	BS	6.7	233	116**	274	0.168**
	AH	7.0	250	119	312	0.157*
2017						
Deep ploughing	BS	7.1	246	136	426	0.120
	AH	7.0	255	144	455	0.128
Shallow ploughing	BS	7.1	245	146	489	0.148**
	AH	7.0	233	158	463	0.141
Deep cultivation-chiselling	BS	7.4	242	148	481	0.131**
	AH	6.8	243	165	485	0.134
Shallow cultivation-disking	BS	7.2	270	168	634	0.149**
	AH	7.0	257	180	610	0.145
No-tillage	BS	7.1	276	166	608	0.143**
	AH	7.1	268	206	544	0.146
2018						
Deep ploughing	BS	7.3	309	123	282	0.116
	AH	7.3	322	132	298	0.115
Shallow ploughing	BS	6.9	347	150	358	0.144*
	AH	6.9	347	156	269	0.164*
Deep cultivation-chiselling	BS	6.6	318	132	242	0.136*
	AH	6.9	300	152	286	0.148*
Shallow cultivation-disking	BS	6.8	336	147	256	0.138*
	AH	6.7	376	188	268	0.161*
No-tillage	BS	6.4*	384	181*	208	0.158**
	AH	6.4*	355	201*	198	0.173**

BS, before sowing; AH, after harvesting; * significantly different at P ≤ 0.05 from the control (deep plowing, DP) within columns; ** at P ≤ 0.01.

Table 2. The effect of the tillage systems on the CO2 e-flux and the concentration above the ground.

Tillage System	CO_2 e-Flux Rate, µmol m^{-2} s^{-1}			CO_2 Concentration Above the Ground, ppm		
	Beginning of Vegetation	Middle of Vegetation	End of Vegetation	Beginning of Vegetation	Middle of Vegetation	End of Vegetation
2016						
Deep ploughing	2.21	4.47	3.88	389.7	383.7	394.2
Shallow ploughing	2.90	3.81	3.27	387.2	409.5	392.4
Deep cultivation-chiselling	3.22	2.93	5.75	387.1	386.3	393.7
Shallow cultivation-disking	2.74	5.06	3.29	391.0	382.9	390.9
No-tillage	2.97	3.97	4.49	386.9	383.1	394.6
2017						
Deep ploughing	3.19	3.43	2.00	387.8	391.8	389.8
Shallow ploughing	2.65	7.66**	2.93	389.0	406.1	388.7
Deep cultivation-chiselling	3.68	4.28	1.80	388.0	399.7	388.0
Shallow cultivation-disking	2.72	3.47	1.65	387.2	410.1*	387.5*
No-tillage	4.55	4.20	2.38	390.8**	393.7	387.4*
2018						
Deep ploughing	3.57	5.02	2.32	390.5	395.2	376.6
Shallow ploughing	2.58	3.07	6.84**	387.4*	388.9	391.1
Deep cultivation-chiselling	2.82	3.12	9.75**	388.1	388.1	393.9
Shallow cultivation-disking	4.33	3.51	5.68*	389.5	388.9	381.4
No-tillage	2.46	3.15	5.54*	388.2	397.0	383.6

* Significantly different at $P \leq 0.05$ from the control (deep plowing, DP) within columns; ** at $P \leq 0.01$.

Conclusions

Ploughless and no-tillage systems increased the amount of available nutrients (N, P, K, and M) in the soil. Faba bean crop largely increased the composition of potassium and total nitrogen and stabilized the soil CO2 respiration during a single vegetative period.

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