Soil respiration in alley-cropping system composed of black locust and poplar trees, Germany.

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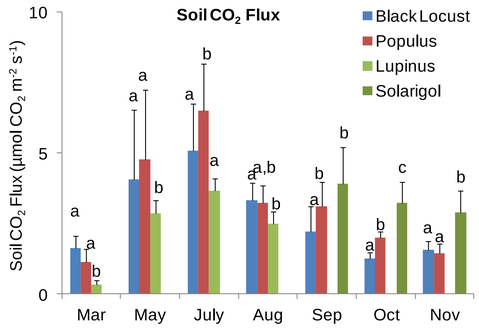
Introduction

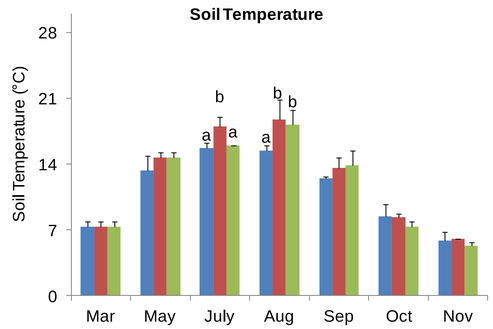
The understanding of changes in soil respiration after establishment of alley-cropping systems is crucial for mitigation of greenhouse gas CO_2. This study investigates soil CO_2 flux in young (2 y.o.) alley-cropping system composed of hedgerows of hybrid poplar (*Max 1*) and black locust (*Robinia pseudoacacia L.*) and adjacent to them crop strips (*Lupinus/ Solarigol*), Germany.

Methods

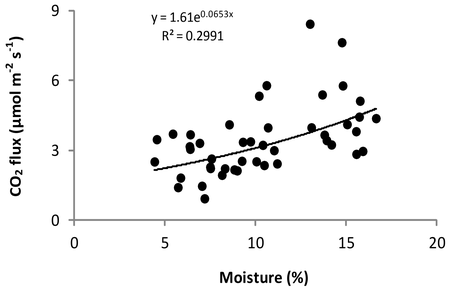
Soil CO_2 flux was measured monthly over March – November 2012 period, using a LI-COR LI-8100A automated device, in poplar, black locust and crop strips (9 measurement collars per each sampling area). Simultaneously with CO_2 flux measurements, soil and air temperature, soil moisture, microbial C and hot water-extractable carbon (HWC) were recorded for soils collected nearby each measurement collar. Root biomass was measured to a depth of 15 cm.

Results

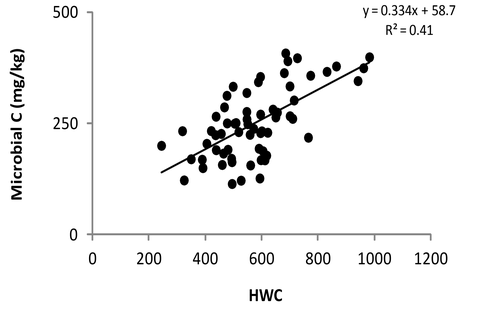




In all vegetation types, soil CO_2 flux increased from May to August, showing a significant positive correlation with air and soil temperature. Over the March - August period. CO_2 flux was significantly ($p<0.05$) higher in trees compared to crops, with the highest values in poplar, followed by black locust and lupines. Over the September - November period, CO_2 flux was significantly ($p<0.05$) higher in catch crop *Solarigol* cultivated in August compared to trees.



Soil moisture was positively ($r=0.553$, $p<0.001$) correlated with CO_2 flux over the May - October period.



Microbial C showed a positive ($r=0.577$, $p<0.001$) correlation with HWC, showing higher values in March and October - November periods.

	Black locust	Poplar	Crop
CO_2 flux (µmol m^{-2} s^{-1})	2.5(1.1)	3.2 (2.1)	2.9 (1.5)
Soil T (°C)	11 (4)	12(5)	12 (5)
Air T (°C)	14 (5)	15 (7)	14(6)
Soil Moisture (%)	13(6)^{ab}	11(5)^{a}	13(3)^{b}
Microbial C (mg/kg)	241(91)	236(71)	275(70)
HWC (mg/kg)	618 (162)^{a}	489(147)^{b}	618(108)^{a}
HWN (mg/kg)	96(19)^{a}	73(20)^{b}	102(22)^{a}
Roots biomass (Mg/ha)	2.0(0.5)^{a}	2.2(0.3)^{a}	0.8(0.0)^{b}

Measured properties, averaged for the whole sampling period (March - November 2012).
^{a,b} - different letters indicate significant difference between sampling areas (Mann-Whitney U Test, $p<0.05$).

		Microbial C	HWC	HWN	HWC:HWN	Moisture	Soil T	Air T
CO_2flux	r	**-.365****	-0.238	-0.027	**-0.573 ****	-0.103	**.643****	**.613****
	p	*.003*	*.061*	*.833*	*.000*	*.421*	*.000*	*.000*
Microbial C	r		**.577****	**.500****	**.260***	.112	**-.447****	**-.478****
	p		.000	.000	.039	*.382*	.000	.000
HWC	r			**.900****	.174	.125	**-.291***	-.239
	p			.000	.172	*.328*	.021	.060

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Spearman correlation coefficients (*r*) for the relationships between variables (n=63) for the data collected across all sampling areas over the March - November 2012 period.

Conclusion

- A positive correlation observed between CO_2 soil flux and soil temperature may be a reflection of higher photosynthetic activity in warm summer months, which results in the higher CO_2 assimilation and translocation belowground via tree stems and roots. Higher roots respiration, and root exudation in summer may prime microbial activity and increase CO_2 flux.

- CO_2 flux varied between vegetation types, and showed peaks in different seasonal periods. Populus and Black locust showed higher CO_2 flux in March - July. In this period trees have higher photosynthetic rates. Greater root density in trees may result in higher root respiration, compared to Lupines.

- After photosynthetic rates decline in trees in autumn, CO_2 flux declines. In contrast, in catch crop, cultivated in August, photosynthesis reaches its peak in September at a period of fast growth of aboveground biomass and roots. This could have resulted in higher CO_2 flux in *Solarigol* crop compared to the tree strips over September - November period.

- A greater C loss with soil respiration from trees hedgerows in summer period may be compensated by greater C assimilation and storage in woody biomass, as well as the lower respiration in autumn, compared to the tilled and reseeded crop strips.

Acknowledgements

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