Influence of soil substrate on nectar production on *Sunflower*

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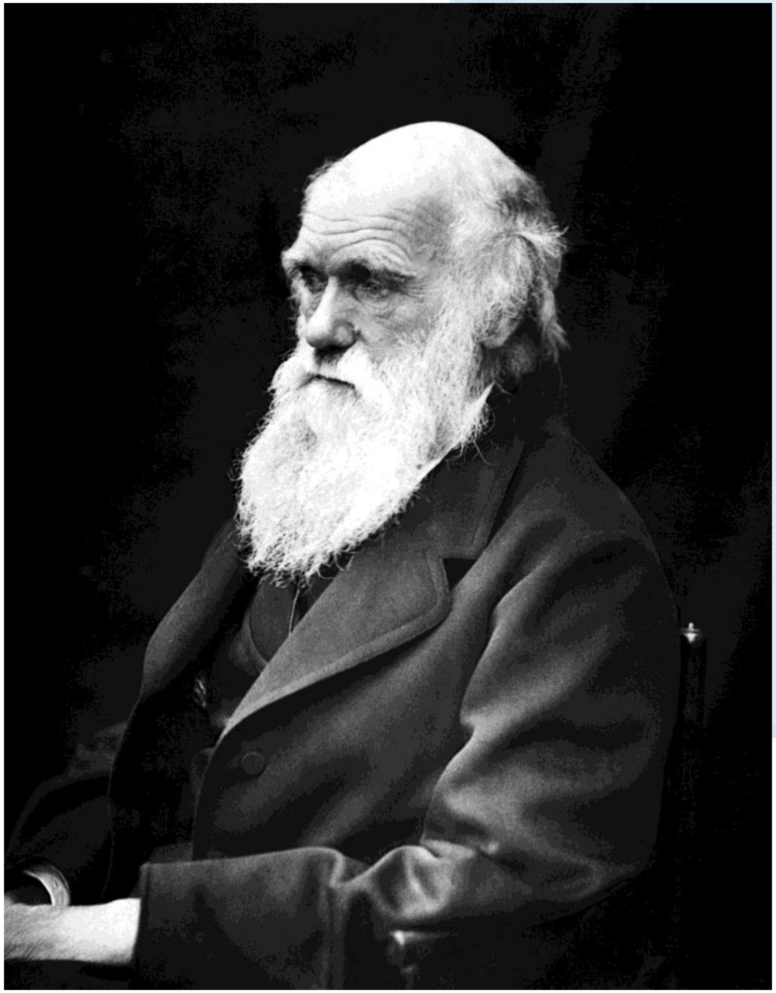
Floral nectar is presented inside the flower close to the reproductive organs and rewards animals that perform pollination while visiting the flower. Nectar is a source of carbon and nitrogen compounds that feed animals, the most abundant solutes being sugars and amino acids. Obtaining the reward/service without returning any counterpart is well-known in mutualistic relationships.



Factors affecting nectar production

Several studies found that under both experimental and natural conditions the nectar volumes and production rates decrease at higher temperatures, high plant water stress (influenced by soil moisture), and low relative air humidity. Despite these environmental factors, the nectar secretion and availability for honey production is affected by:

- Floral resources and land cover
- Pest of the insect
- Pesticide exposure
- Apicultural mismanagement
- Long-distance transport
- Decreased genetic diversity
- Certain soil properties

Sunflower nectar and honey production

Sunflower (Helianthus annuus L.) is a cross-pollinated plant that belongs to the family of Asteraceae, which requires insects – especially honeybees– to do pollination for seed production. Studies suggest that in the last 20 years the honey production from sunflower decreased dramatically. Many theories were put forwards; among others, the use of new hybrids respect old population seems the most widely accepted. However, there are still may doubts regarding the sunflower nectar production decline.

Objective of the study

Relationship among soil conditions and nectar quantity and quality are not completely understood.

- The first objective of the research was to study the interaction among soil and nectar and the influence of compost.

- The second objective was to study the preference of pollinators among different sources of nectar.

Materials and methods

In order to study the influence of soil on nectar, three soil treatments were identified: **CONTROL** (no fertilizer application), **CHEMICAL** (only fertilizer application), **COMPOST** (only compost application).
Nine plots, three per treatment, of 16 m^2 (4 m x 4 m) were organized in three blocks (three plots per block) according to a randomized block experimental design.

CONTROL = no application

CHEMICAL (NPK 15-15-15) = 30 g m^2 (corresponding to 300 kg ha^{-1}) for two applications

COMPOST = 3 kg m^2 (corresponding to 30 Mg ha^{-1}) for one application

Materials and methods

During crop development the plants was sampled using Dualex leafclip sensor to measure chlorophyll and polyphenols content of plant leaves. This optical sensor allows non-destructive measurement of chlorophyll, flavonols and anthocyanins in leaves and calculate the NBI® (Nitrogen Balance Index) that combines chlorophyll and flavonols (related to nitrogen/Carbon allocation).

Materials and methods

In order to measure nectar composition and concentration of sugars the rinsing method was used. Ten flowers at the same stage were collected from the same inflorescence and sealed in a Falcon test tube with 5 ml of distilled water.
The level of soluble solids residue (SSR) was measured by refractometry, unity of measure used for SSR was Brix (°Bx). Single sugars concentrations were measured by HPLC, injecting an aliquot of the clean extract into the chromatograph.

Materials and methods

Inside the greenhouse the soil was sown with two varieties of Sunflower (Helianthus annuus L.). The left part was sown with a non-hybrid variety “Irish eye” while the right part with the hybrid variety (Ref. N° LST 907) utilized in the other field experiment. To study the pollinators activity inside the greenhouse were installed 2 image acquisition points for each variety for a total of 4.

Results of soil sampling

Treatments	Clay (% d.m.)	Silt (% d.m.)	Sand (% d.m.)	pH	C organic (% d.m.)	N (% d.m.)	Olsen P (mg/kg d.m.)	Interchangeable K (mg/kg d.m.)
Before ploughing	19.1±4.3	30.5±6.5	50.4±10	7.7±0.5	2.2±0.4	0.15±0.027	149±30	204±29
CONTROL	18.7±4.2	30.1±6.5	51.2±10.1	7.8±0.5	2.3±0.42	0.18±0.033	211±40	252±35
CHEMICAL	18.9±4.2	31±6.6	50.1±10	7.8±0.5	2.7±0.49	0.19±0.034	227±42	224±31
COMPOST	20.1±4.5	29.5±6.3	50.4±10	7.7±0.5	3±0.54	0.24±0.043	226±42	306±43

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Results of nectar sampling

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Parameter	Sampling 28th June		
	CON	CHEM	COMP
Oligosaccharides (mg/mL)	0.10±0.05	0.051±0.04	0.068±0.002
Raffinose (mg/mL)	0.05±0.02	0.03±0.02	0.05±0.008
Sucrose (mg/mL)	0.015±0.004	0.010±0.01	0.017±0.002
Glucose (mg/mL)	0.54±0.13	0.34±0.20	0.21±0.019
Fructose (mg/mL)	0.64±0.26	0.46±0.17	0.35±0.08
Total (mg/mL)	1.35±0.34	0.90±0.46	0.70±0.11
°Brix (%)	0.17±0.07	0.15±0.04	0.14±0.04
Mean total/Brix	8.28±1.97	5.63±1.38	5.18±0.94

Results of biomass harvesting

Treatment	Stem (kg f.m.)	Moisture content (%)	Inflorescences (kg f.m.)	Moisture content (%)
CON	19.97±1.76 a	75.68±4.73 a	10.57±1.02 a	78.95±0.6 a
CHEM	24.57±2.37 b	76.83±2.76 a	13.07±1.4 a	78.73±2.13 a
COMP	24.97±4.61 b	79.12±0.62 b	12.7±3.29 a	80.13±1.83 a

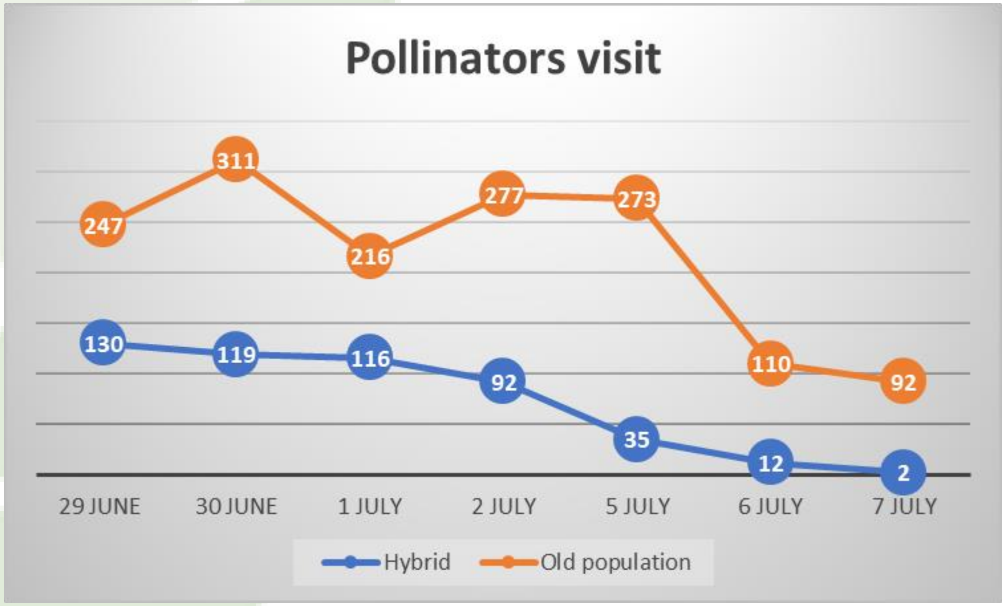
Results of leaf sampling

22nd June sampling				
Treatment	Chlorophyll	Flavonols	Anthocyanins	NBI®
CON	37.560±2.1	1.218±0.4	0.158±0.01	42.811±2.7
CHEM	37.005±5.7	1.360±0.2	0.163±0.01	32.824±5.5
COMP	38.223±1.6	1.169±0.6	0.156±0.01	43.741±3.2
5th July sampling				
Treatment	Chlorophyll	Flavonols	Anthocyanins	NBI®
CON	37.241±1.0	1.294±0.1	0.18±0.006	36.35±1.6
CHEM	36.454±4.1	1.288±0.19	0.18±0.01	36.35±7.8
COMP	36.750±2.3	1.282±0.6	0.18±0.003	37.99±3.0

Results of greenhouse sampling

Parameters	Sampling 28th June	
	Hybrid variety	Non-Hybrid variety
Oligosaccharides (mg/mL)	0.10±0.083	0.05±0.029
Raffinose (mg/mL)	0.06±0.052	0.02±0.019
Sucrose (mg/mL)	0.025±0.015	0.015±0.009
Glucose (mg/mL)	0.30±0.284	0.12±0.093
Fructose (mg/mL)	0.38±0.226	0.23±0.102
Mannitol (mg/mL)	/	0.08±0.095
Total (mg/mL)	0.88±0.660	0.54±0.148
°Brix (%)	0.14±0.070	0.1±0.02
Mean total/Brix	5.38±2.31	5.37±0.44

Results of image analysis



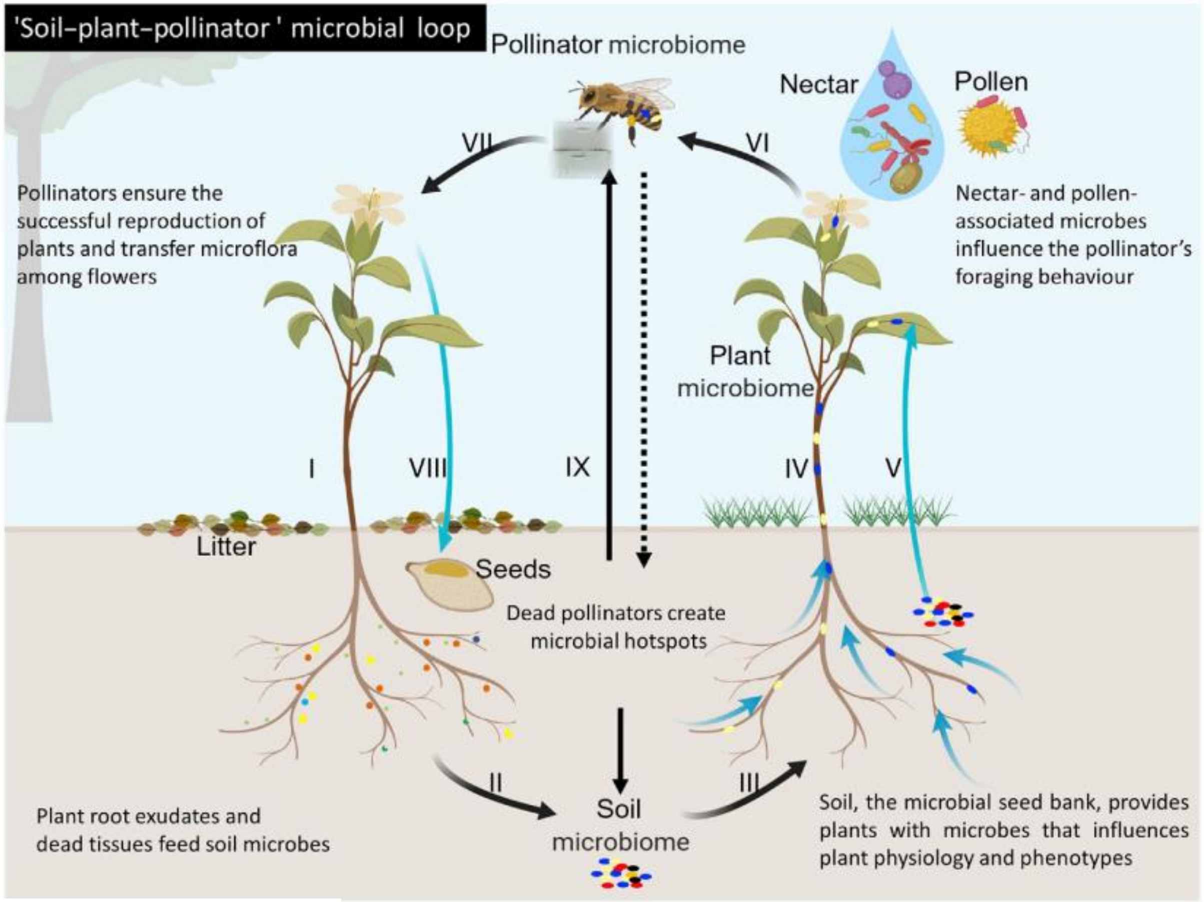
Conclusions

- Evidence of soil impact on nectar
- Importance of maintaning soil and soil quality
- Effect of compost on biomass production and nectar
- Pollinators preferences?
- Role of natural environments

Discussion

Key Figure

A Schematic Diagram for the Proposed Microbial (Ecological) Loop between Plants, Pollinators, and Soils



Thanks for your attention

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