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Znanstveni časopis *Hrvatski meteorološki časopis* nastavak je znanstvenog časopisa *Rasprave* koji redovito izlazi od 1982. godine do kada je časopis bio stručni pod nazivom *Rasprave i prikazi* (osnovan 1957.). U časopisu se objavljuju znanstveni i stručni radovi iz područja meteorologije i srodnih znanosti.

Scientific journal *Croatian Meteorological Journal* succeeds the scientific journal *Rasprave,* which has been published regularly since 1982. Before the year 1982 journal had been published as professional one under the title *Rasprave i prikazi* (established in 1957). The *Croatian Meteorological Journal* publishes scientific and professional papers in the field of meteorology and related sciences.

Hrvatski meteorološki časopis – Croatian Meteorological Journal, 53, 2018., 65–66

Poster

ENERGY BUDGET AT THE EXPERIMENTAL VINEYARD IN ZAGREB

Analiza tokova energije u eksperimentalnom vinogradu u Zagrebu

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Abstract: Within the collaboration of VITiculture and CLImate Change in Croatia (VITCLIC) project and Croatian-Hungarian bilateral scientific program, micrometeorological measurements are performed at the Faculty of Agriculture experimental vineyard near Zagreb in the hilly experimental field during the vegetation periods of 2017/2018 and 2018/2019. The microclimate of two places of cordon cultivated grape has been studied for the investigation of the effect of cultivation method. In one row, the grapes were left to be naturally covered by leaves, while in the other row the leaves were being thinned corresponding to the cultivation method. For characterizing the microclimate, the relative humidity and air temperature, wind speed and direction, UV radiation, leaf wetness and leaf temperature were measured inside the cordon rows among the leaves. Air temperature, relative humidity and wind speed gradient have also been measured above the plants. Radiation budget components were detected with CNR1 net radiometer. Heat flux into the soil and the soil temperature and moisture profiles from the surface to a depth of 1 m were also determined. Two soil heat flux plates were set at 8 cm deep. Measurement frequency was 5 sec and the average time was 1 min using Campbell data collecting systems. Our goal, besides the agroclimatological investigations, is the estimation of soil and surface energy budget components (using Bowen-ratio and gradient methods) and the determination of the optimum roughness length and displacement height as a function of the wind velocity. Daily variation of meteorological elements and energy budget components are demonstrated with case studies.

Key words: micrometeorology, vineyard, energy budget

Sažetak: U sklopu kolaboracijskog projekta VITiculture and CLImate Change in Croatia (VITCLIC) i hrvatsko-mađarskog bilateralnog znanstvenog programa provedena su mikrometeorološka mjerenja u eksperimentalnom vinogradu Agronomskog fakulteta blizu Zagreba, u brdovitom eksperimentalnom području, tijekom vegetacijskih perioda 2017./2018. i 2018./2019. Proučena je mikroklima dva mjesta na kojima se uzgaja grožđe zasađeno u redovima kako bi se ispitao utjecaj metode uzgoja. U jednom redu grožđe je bilo na prirodan način pokriveno lišćem, dok je u drugom lišće bilo prorijeđeno ovisno o metodi uzgoja. Za karakterizaciju mikroklime u redovima, među lišćem bili su mjereni relativna vlažnost i temperatura zraka, iznos brzine i smjer vjetra, UV zračenje te vlažnost i temperatura lista. Temperatura i relativna vlažnost zraka te gradijent brzine vjetra bili su mjereni iznad biljaka. Komponente zračenja određene su CNR1 radiometrom. Određeni su i tok topline u tlo, temperaturni profil i profil vlage od površine do dubine tla od 1 metra. Dvije ploče za mjerenje toka topline u tlu postavljene su na 8 centimetara dubine. Frekvencija mjerenja iznosila je 5 sekundi, a vrijeme usrednjavanja 1 minuta, a koristio se Campbell sustav za prikupljanje podataka. Naš cilj, osim agroklimatoloških istraživanja, je procjena tokova energije u tlu i na površini (korištenjem Bowenovog omjera i metode gradijenata), određivanje optimalne duljine hrapavosti i visine pomaka kao funkcije brzine vjetra. U ovom istraživanju prikazane su dnevne varijacije meteoroloških elemenata i tokova energije.

Ključne riječi: mikrometeorologija, vinograd, tokovi topline

Energy budget at the Experimental Vineyard in Zagreb

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Introduction

VITiculture and CLImate Change in Croatia (VITCLIC) is a new project in Croatia for the analysis of the current situation in viticulture; its focus is on changes in the times of harvest and the basic parameters of quality grapes.
Micrometeorological measurements are performed at two locations: i) in the Istrian peninsula and ii) in the viticulture and wine experimental station at the Faculty of Agriculture near Zagreb (partly supported by the Croatian-Hungarian bilateral scientific program) during the vegetation periods 2017–2018 and 2018–2019.

Motivation

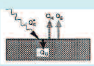
Our goal was to estimate the sum of heat fluxes and net radiation on the surface of experimental Vineyard in Zagreb. The resulting energy plays an important role in heating objects near surface. Furthermore, energy budget is fundamental procedure in planetary boundary layer modeling. This calculation is good test for our experimental devices and their arrangement as well.

A micrometeorological measurements are performed in the Faculty of Agriculture experimental vineyard near Zagreb in the hilly experimental field during the vegetation periods 2017–2018 and 2018–2019. Microclimate of two places of cordon cultivated grape have been studied for the investigation of the effect of cultivation method. In one row grape was left to be naturally covered by leaves while in the other the leaves were being thinned corresponding to the cultivation method.

Theory

The energy budget for infinitesimally thin layer shown on the picture below is:

$$-Q_S = Q_H + Q_E - Q_G.$$



Q_S is upward radiation at the surface,

$Q_H = c_p \langle w'\theta' \rangle$ upward sensible heat flux out of the top

$Q_E = L_V \langle w'q' \rangle$ upward latent heat flux out of the top

Q_G upward molecular heat flux into the bottom.

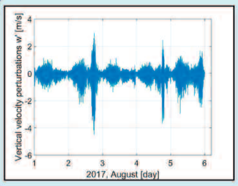
The Bowen ratio is defined as $\beta = Q_H / Q_E$ at the surface. We measured w' and θ' near surface what directly gives result for Q_H. Since there was no possibility to measure q', we calculated Bowen ratio using formula:

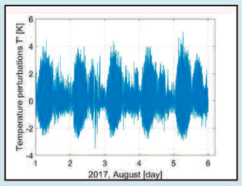
$$\beta = 1.46\left(\frac{1}{RH}\right)\left(\frac{T}{273}\right)^2 \exp\left[-19.83\left(1-\frac{273}{T}\right)\right]$$

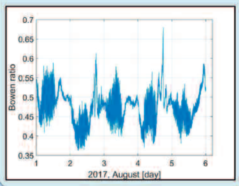
Relative humidity *RH* and absolute temperature *T* were measured at the same height as w'. Then Q_E was calculated as $Q_E = Q_H / \beta$. Ground heat fluxes are calculated using gradients at depth 2cm, 5cm, 40cm, 100cm which are interpolated to the surface level. For this calculation we used formula

$$Q_G = -k_g \Delta T / \Delta z$$

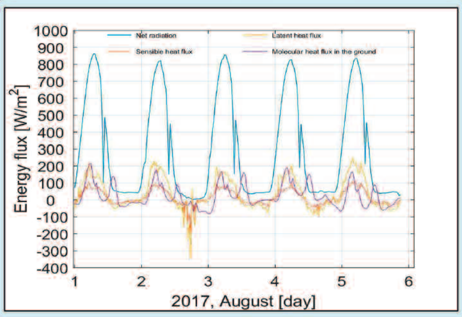
Results

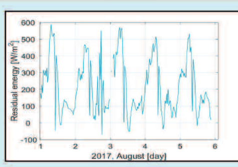


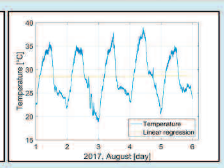




Vertical velocity perturbations are usually the smallest at the midnight, and variability is around 6m/s.
Temperature perturbations also tend to be the smallest at midnight, and their variability is around 6K.
Bowen ratio values varies between 0.35 and 0.7.
This high-frequency data is later averaged in 30 minute intervals.







Residual energy shows daily variability of 600 W/m^2, with maxima usually in the morning. Air temperature shows similar behaviour, but less variable. Residual energy is mostly positive, what can be caused because of slight temperature rising, what is, further, connected with yearly temperature behaviour.

Instrumentation

In the canopy (80 cm):

2 x Kipp & Zonen SUV5 Broadband UV Radiometer
2 x YOUNG Model 41382 RH/T probe with a radiation shield
2 x Gill WindMaster 3D Anemometer
Campbell Scientific CR-3000 data logger, solar powered, 3G modem

Tower:

2 m: Kipp & Zonen CNR-1 – 4 component radiometer,
Vaisala HMP-45 T/RH sensor
4 m: Vaisala HMP-45 T/RH sensor, Kipp & Zonen PQS1 PAR sensor, Vaisala WAA15A cup anemometer
10 m: Gill WindMaster 3D Anemometer

Soil:

Campbell Scientific CR23X datalogger
1 x Thermocouple Type-E (ref, in box)
3 x Campbell CS616 soil-moisture sensor (1 m, 40 cm, 5 cm deep)
1x Campbell 237-L Leaf-Wetness Grid
4 x Campbell T107 Temperature Probes (1 m, 40 cm, 5 cm, 2 cm deep)
1 x Campbell IRTS-P infrared thermometer (80 cm above ground)
2 x Hukseflux HFP01 heat-flux plate (8 cm), self calibrated

Meteorological tower (10 m) with solar panels, radiation, temp. humidity and wind measurements

Picture shows instruments in first 2 meters. For characterizing the microclimate the relative humidity and temperature, wind speed and direction, UV, leaf wetness and leaf temperature were measured inside the cordon rows among the leaves. Temperature, relative humidity and wind speed gradient have been also measured above the plants.

Data used in this poster is provided by the HrZZ project (VITCLIC) (PKP-2016-06-2975) which is funded by the Environmental protection and energy efficiency fund under the Government program (Ministry of environment and energy & Ministry of science and education) for the Promotion of research and development activities in the field of climate change for the period 2015–2016.

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