



Green Room and University of Montenegro



GREEN ROOM SESSIONS 2018

**International GEA (Geo Eco-Eco Agro) Conference
1-3 Novembar 2018, Podgorica, Montenegro**

**Plant production, Plant protection & Food safety, Genetic resources
Phytochemistry and Medicinal Plants, Animal husbandry and Dairy production
Rural development and agro-economy, Rural Environments and Architecture
Environment protection and natural resources management, Forestry**

GREEN ROOM SESSIONS 2018

Book of Proceedings



Podgorica, Montenegro, 2018

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FOREWORD

Green Room Sessions International Conference aims to be platform for international scientific discussion on agriculture in general as well as agriculture in conjunction with economics and ecology, food and nutrition science and technology, rural development, environment and forestry. Green Room Sessions brings together and is connecting research, industry, social concepts and practices. The scientific core is based on applying Eco-Eco (ecological-economical) concepts and principles to optimize interactions between natural, social and built components of the rural environments: plants, animals, soil, water, air, humans and man-made structures. In addition, Green Room Sessions placed social issues at the centre of solutions for a sustainable and fair food system. Green Room Sessions are targeting to multiple benefits to society and the environment, by bringing people together and providing them the opportunity to sit together and exchange ideas and connect the business.

In November 2018, the 1st Green Room Sessions International Conference provided an opportunity for sharing experiences and builds the evidence base on agriculture, forestry, human interactions and built environment, as well as reaching a consensus on the priorities for achieving more sustainable food systems. It also endorsed Institutional roles of National services, Regional and International organisations in supporting further implementation and promotion of Eco-Eco (ecological-economical) concepts and principles.

Dialogue between the participants targeted:

- Enhancing smallholder and family farmers' adaptation and resilience to the impacts of climate change;
- Improving nutrition including through more diversified diets;
- Protecting and enhancing agro-biodiversity in support of ecosystem services;
- Improving livelihoods in rural areas;
- National Food Wealth, the holy trinity: agriculture, economics and ecology (a x e²);
- Mutual interconnections and how to deal with them and how this mix influence National Food Wealth and National Health.

achieving a transformative change in agricultural practices towards sustainable development.

The Green Room Sessions International Conference synthesized and build on the outcomes of the regional meetings, and provided an opportunity to share and discussed policies that can help scale-up and scale-out agriculture, rural development, agroecology, nutrition in order to achieve the Sustainable Development Goals.

The Symposium also moved the topic of agriculture and rural development from dialogue to activities at the regional and country level by complementing on-going initiatives to integrate biodiversity and ecosystem services in agriculture, identifying opportunities for synergies with National Strategic Programmes and Regional Initiatives, and facilitating regional and International cooperation between the scientists and business.

Green Room Sessions International Conference as a final goal is looking forward to assist people from the rural areas, related business, agriculture and allied sectors to take the advantage of:

- Natural resources, secure access to land and water, and improved natural resource management and conservation practices;
- Improved agricultural technologies and effective production services;
- Linking the interested parties with financial services;
- Transparent and competitive markets for agricultural inputs;
- Opportunities for rural off-farm employment and enterprise development;
- Local and national policy and programming.

We launch this with the aim of unlocking innovative, integrated, multidisciplinary science and technology with activation of all dimensions of sustainable development goals for all the participants.

In this Book of Proceedings we published part of the original scientific full papers presented at the Conference. The other part is provided for publication at the journal Agriculture and Forestry (ISSN 0554-5579, Printed; ISSN 1800-9492, Online), all based on the requests of the authors who participated at the Conference.

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PREDGOVOR

Međunarodna konferencija Green Room Sessions imala je za cilj da bude platforma međunarodne naučne diskusije o poljoprivredi uopšte, poljoprivredi vezano sa pitanjima ekonomije i ekologije, nauci o tehnologiji hrane i prehrane, ruralnim razvojem, životnom sredinom i šumarstvom. Green Room Sessions okupila je i povezivala nauku, istraživanje, industriju, društvene koncepte i prakse.

Naučni principi zasnovani su na primjeni Eko-Eko (ekološko-ekonomskih) koncepata za optimizaciju interakcije između prirodnih, socijalnih i komponenti ruralnih sredina: biljka, životinja, zemljište, voda, vazduh, kao i strukture koje su nastale kao plod rada ljudi. Pored toga, Green Room Sessions je težila da postavi društvena pitanja u centar rješenja održivog i fer sistema proizvodnje hrane. Brojni sastanci održani su tokom Konferencije sa ciljem da imaju višestruke koristi za društvo i sredinu koja nas okružuje, približavajući tokom ovih komunikacija ljude jedne drugima, pružajući im priliku da međusobno komuniciraju na jednom mjestu, razmenjuju ideje i povezuju poslovanja.

U novembru 2018. godine, Green Room Sessions International Conference pružila je mogućnost razmjene iskustava potvrđenih praksi u poljoprivredi, šumarstvu, interakcijama čovjeka i njegovog okruženja, struktura koje su nastale kao plod rada ljudi. Ovo je postignuto organizovanjem susreta naučnika i stručnjaka iz ove oblasti, te razmjenom iskustava, doprinoseći unapređenju održivijeg sistema proizvodnje i prerade. Iskustva drugih koji su gostovali istakli su značaj institucionalne uloge nacionalnih službi, regionalnih i međunarodnih organizacija u podršci i daljoj promociji eko-eko (ekološko-ekonomskih) koncepata i principa.

Dijalog između učesnika bio je usmjeren na:

- Prilagođavanje malih proizvođača i porodičnih farmera i jačanje njihove otpornosti na uticaj klimatskih promjena;
- Zaštitu i unapređenje agro-biodiverziteta, podrške održivosti ekosistema;
- Poboljšanje životnih uslova, životnog standarda u ruralnim područjima;
- „Sveto trojstvo“: poljoprivreda, ekonomija i ekologija ($a \times e^2$), njihove međusobne veze i kako se baviti njima, te kako ovaj miks međusobnih relacija utiče na proizvodnju domaće hrane i zdravlje nacije;

- Postizanje tranzicionih promjena u poljoprivrednim praksama u skladu sa principima održivog razvoja.

Konferencija je dijelom uradila sintezu i nadograđivala rezultate regionalnih sastanaka i pružiti priliku da podijeli svoja iskustva sa učesnicima, diskutuje o politikama koje mogu pomoći u povećanju poljoprivredne proizvodnje, ruralnog razvoja, agroekologije, ishrane kako bi se postigli ciljevi održivog razvoja.

Konferencija je takođe inicirala pomjeranje teme poljoprivrede i ruralnog razvoja od dijaloga ka konkretnim aktivnostima na lokalnom i regionalnom nivou, tražeći rješenja očuvanja biodiverziteta u poljoprivredi, identifikujući mogućnosti za sinergiju sa nacionalnim strateškim programima i regionalnim inicijativama, pospešujući regionalnu i međunarodnu saradnju između naučnika i biznisa.

Učesnici na Konferenciji tražili su načine da se pruži pomoć ljudima iz ruralnih područja, njihovim malim biznisima, poljoprivredi i srodnim sektorima da iskoriste prednosti:

- Prirodnih resursa, bezbjednog pristupa zemljištu i vodama, poboljšavajući prakse upravljanja prirodnim resursima i pristupe konzervacije;
- Poboljšane poljoprivredne tehnologije i efikasnijih proizvodnih usluga;
- Povezivanje zainteresovanih strana sa finansijskim servisima;
- Mogućnosti za zapošljavanje i razvoj preduzeća u ruralnim područjima;
- Lokalnih i nacionalnih politika i programiranja.

Ovo inicijativa je pokrenuta sa ciljem otvaranja i susreta sa inovativnom, integrisanom, multidisciplinarnom naukom i tehnologijom uz aktiviranje svih dimenzija ciljeva održivog razvoja za sve učesnike.

U ovom Zborniku radova objavili smo dio originalnih naučnih radova (*Full papers*) predstavljenih na Konferenciji. Drugi dio je prosljeđen za objavljivanje časopisu Poljoprivreda i šumarstvo (ISSN 0554-5579, print; ISSN 1800-9492, online), sve na osnovu zahtjeva autora koji su učestvovali na Konferenciji.

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U ime Naučnog i Počasnog odbora

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Original Scientific paper

Effects of irrigation on production and quality of marigold and basil in different weather conditions

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Abstract

Irrigation improves the water regime of soil creating favorable conditions for growing plants. Frequent oscillations of weather conditions in the region, first of all the amount and distribution of precipitation, are the reason why irrigation is needed in plant production. The aim of the study was to detect the effect of irrigation on the yield and quality of marigold (*Calendula officinalis* L.) and basil (*Ocimum basilicum* L.). The experiments were conducted at the experimental field of the Institute of Field and Vegetable Crops. Irrigation was scheduled on the basis of the water balance method. Daily evapotranspiration (ET_a) was computed from the reference evapotranspiration (ET_o) and crop coefficient (kc) in May, June, July and August of 0.5, 0.6, 1.1 and 1.0, respectively. ET_o was calculated using Hargreaves equation. The irrigation depth was restricted to the soil depth of 0.3 m. In other words, irrigation started when readily available water in the soil layer of 0.3 m was completely depleted by plants. The irrigation rate was 30 mm (30 l⁻¹ m⁻²) while the amount of water added by irrigation during the season was 120 mm in 2016 and 300 mm in 2017. According to the results, the yield of fresh herb of all two plants under irrigation was higher compared to non-irrigated, control variant. As well essential oil and carotenoids, the main indicators of the quality of investigation plants were also affected by irrigation.

Key words: Irrigation, dill, marigold, basil, production, quality components

Introduction

Irrigation improves the water regime of soil creating favorable conditions for growing plants. Frequent oscillations of weather conditions in the region, first of all the amount and distribution of precipitation, are the reason why irrigation is needed in plant production. Environmental conditions (weather and soil) have a significant effect on grain yield and quality in sweet basil (Pejić et al. 2017).

Water availability and quality are issues of major concern in reference to irrigation of urban landscapes resulting from the competition with a rapidly growing population that requires vast volumes of good-quality water (Kjelgren et al. 2000). Landscape irrigation accounts for 10% of total volume in the summer rainfall region of the United States, whereas in the arid western regions, irrigation of landscape accounts for nearly 50% (Kjelgren et al. 2000).

In Serbia, basil (*Ocimum basilicum* L. *Lamiaceae*) has been grown traditionally as a decorative, medicinal, seasoning and ritual herb, and there is a variety of different populations of basil. Basil is considered to have been brought to Serbia in the 12th century by monks returning from their pilgrimages (Picture 1b and c). Essential oils of all tested basil populations were light yellow and had a specific aromatic scent. Basil populations traditionally grown in Serbia have exceptional quality.

They represent an excellent raw material for the production of basil essential oils, for the needs of pharmaceutical, food and chemical industry (Jelačić et al. 2011).

Marigold (*Calendula officinalis* L.), one of the most important ornamental plants, is valued in landscape settings and also as cut flowers (Nau, 1997; Popović, 2010; 2017; 2018). Marigold is grown as an ornamental crop for its flowers (Picture 1a) which are sold in the market as loose flowers in bulk, as specialty cut flowers, or for making garlands. Demand of marigold as cut flower or as a extracted products is high in many countries (Spain, Mexico, UK, United States, Italy, South Korea, Taiwan, Japan). Hence, Exporting of marigold will increase the economic level (Luis et al., 2009).



Picture 1. Marigold, a, and basil in the field, b and c, Bački Petrovac, Serbia, 2017

Water is becoming an economic scarce resource in many areas of the world, especially in arid and semi-arid regions (Bosma et al. 2003). Agriculture is the largest consumer of global freshwater, accounting for around 70% of withdrawals as irrigation (WWAP, 2009). Increasing the efficiency of water use within agriculture systems is important in order to secure water for agricultural production. Potential water saving strategies has been estimated that, better irrigation scheduling and use of drip irrigation in row crops may save 20% of the water consumption (EU WSPP, 2017).

Proper irrigation scheduling results in increasing water use efficiency (WUE). WUE relates to how much yield is obtained per unit of applied water. Scheduling water application is very critical, as excessive or inadequate irrigations reduce yield, while inadequate irrigation also causes water stress (Sujitha and Shanmugasundaram, 2017).

The aim of the study was to detect the effect of irrigation on the yield and quality of marigold (*Calendula officinalis* L.) and basil (*Ocimum basilicum* L.).

Material and methods

The experiments were conducted at the experimental field of the Bački Petrovac Department, Institute of Field and Vegetable Crops, Novi Sad (N 45°20', E 19°40', 82 msl). Irrigation was scheduled on the basis of the water balance method. Daily evapotranspiration (ET_d) was computed from the reference evapotranspiration (ET_o) and crop coefficient (k_c) in May, June, July and August of 0.5, 0.6, 1.1 and 1.0, respectively.

ET_o was calculated using Hargreaves equation. The irrigation depth was restricted to the soil depth of 0.3 m. In other words, irrigation started when readily available water in the soil layer of 0.3 m was completely depleted by plants.

The irrigation rate was 30 mm while the amount of water added by irrigation during the season was 120 mm in 4 watering in 2016 and 300 mm in 10 watering in 2017.

Statistical Analysis

Experiment was set as one factorial split plot method (split-plot), with three replications. Results were interpreted by using a statistical package, statistic 12.

Climatic data

The climatic data for the growing period in Bački Petrovac, near Novi Sad are shown in Figure 1a, b. Irrigation in critical plant development stages is a crucial factor for the successful production. During the vegetation period in 2016 and 2017, there was total precipitation of 440 mm and 219 mm and average temperature of 19.4°C and 21°C, Figure 1a, 1b.

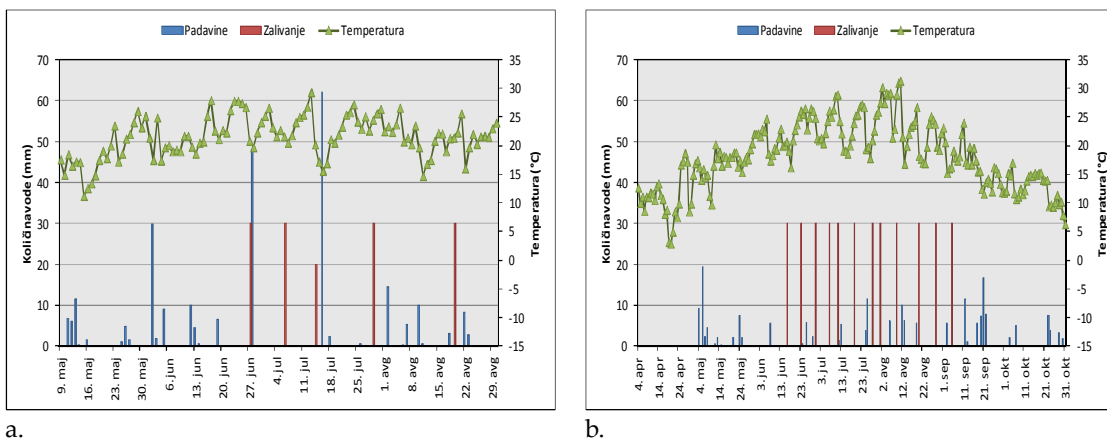


Figure 1. Climatic data for the growing period in Bački Petrovac, 2016, a, 2017b, Serbia

Results and Discussion

For all two plant species (marigold and basil) higher yield of biomass was achieved in 2016 compared to arid 2017. Year and irrigation had a statistically significant impact on the yield of biomass for all tested crops, Table 1 and Figure 2.

Basil had a significantly higher average biomass yield (27608.50 kg ha⁻¹) compared to marigold (9002 kg ha⁻¹), Table 1 and Figure 2.

The average yield of basil biomass, on average for the study period, varied from 24513 kg ha⁻¹ (control) to 30704 kg ha⁻¹ (irrigated), Table 1 and Figure 2.

The average yield of marigold biomass varied from 7245 kg ha⁻¹ (control) to 10759 kg ha⁻¹ (irrigated) (Table 1).

Marigold had a higher average carotenoids content in variant with irrigation (0.874 %) compared to control (0.557%), Table 1.

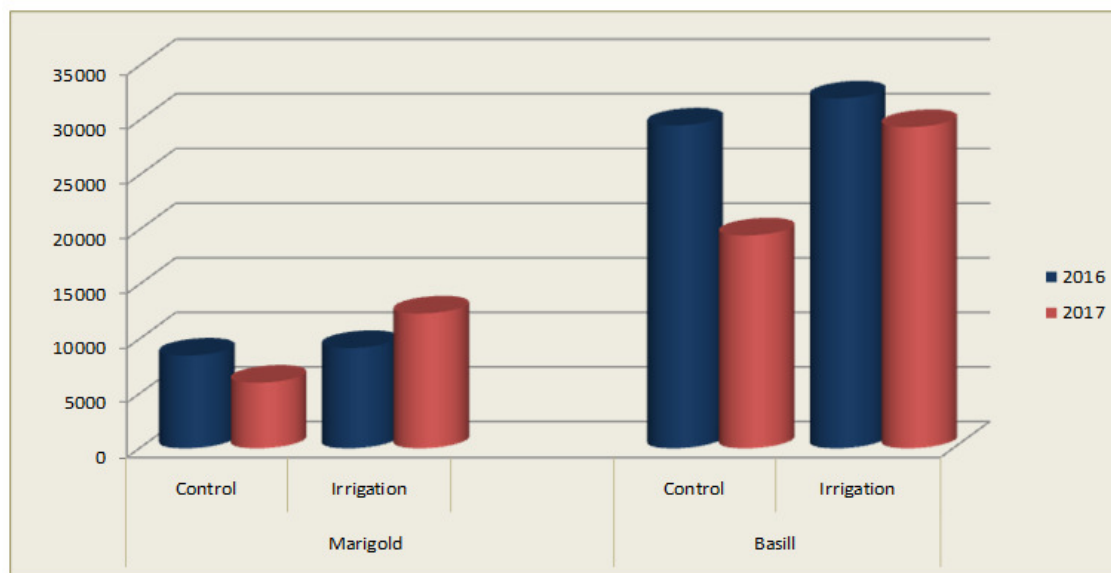
The effect of irrigation on yield it was noticed in both years, rainy 2016 from 8.36% for basil to 8.18% for marigold and in dry 2017, 50.87% at basil to 105.46% at marigold. In irrigation conditions, in both years of production, increased with yields of green biomass and yields of essential oils and carotenoids, as the main indicator quality cultivated crops.

Basil essential oils of all tested basil populations were light yellow and had a specific aromatic scent. The composition of essential oil in the dry herb of the tested populations ranged from 0.87 to 1.84%. The results of gas chromatographic analysis of essential oils in tested basil populations pointed to their complex chemical composition and to the fact that they belong to the most appreciated European chemotype. In total, 33 components have been identified in the essential oils.

The most common fraction of components in all tested oils was terpenoids. The predominant component in all essential oils is monoterpen linalol, ranging from 51.52 to 74.73% (Jelačić et al. 2011).

Table 1. Yield of biomass, kg/ha, essential oil and carotenoids, %, of dill, marigold and basil, 2016-17

Parameter	Year	Data of mowing	Control	Irrigated	Difference	Effect, %	Irrigation norm, mm	
Marigold								
Yield of biomass, kg ha ⁻¹	2016	30.6-29.8.	8484	9178	694	8.18	120 (4)	
	2017	21.6-18.8.	6006	12340	6334	105.46	300 (10)	
	Average	-	7245	10759	-	-	-	
Carotenoids, %	2017	-	0.5574	0.8738	0.3164	56.76	-	
Basil								
Yield of biomass, Kg ha ⁻¹	2016	I	20.07.	17005	18587	1582	9.30	120 (4)
		II	30.08.	12539	13428	889	7.09	
		X	-	29544	32015	2471	8.36	
	2017	I	31.07.	11786	16893	5107	43.33	300 (10)
		II	19.09.	7696	12500	4804	62.42	
X		-	19482	29393	9911	50.87		
Average	-	-	24513	30704	-	-	-	
Essential oil content, %	2017	-	0.632	0.761	0.129	20.41	-	

**Figure 2.** Average yield of biomass in control and irrigated of marigold and basil, 2016-2017

Growth of marigold plants irrigated with water at pH 6.4 significantly decreased as EC_w increased; however, the aesthetic value of the plants was not detrimentally affected (Luis et al. 2009). Although, according to literature, dill no great demands on the water, for successful plant production requires a favorable water and air regime in the soil, why it is necessary to irrigate in droughty years, thus achieving high yields of improved quality, and therefore better profitability of growing this spice plants (Maksimovic et al. 2018b). Environmental conditions (weather and soil) have a significant effect on grain yield and quality in sweet basil (Pejić et al. 2017; Maksimović et al. 2018a, 2018b).

Biomass shows a tendency to increase in the years having a higher total amount and better distribution of rainfall during critical plant development stages. Irrigation in these phases is a crucial factor for the successful production of marigold and basil.

Conclusions

According to the results, the yield of fresh herb of all three plants under irrigation was higher compared to non-irrigated, control variant. As well essential oil and carotenoids, the main indicators of the quality of investigation plants were also affected by irrigation.

Environmental conditions have a significant effect on biomass yield and quality in basil and marigold. A more favorable year for the production of biomass was 2016 compared to the drought of 2017.

Basil and marigold populations traditionally grown in Serbia have exceptional quality. They represent an excellent raw material for the production of basil essential oils, for the needs of pharmaceutical, food and chemical industry.

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Conflicts of Interest: The authors declare no conflict of interest.

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