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Application of wine and olive oil production wastes as substrates for the successful cultivation of *Chrysanthemum indicum* potted flowers

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Peat is the dominant potting medium material

The major component of substrates for potted plant production due to the **appropriate physical properties** (low bulk density, high porosity and water holding capacity) and the high cation exchange capacity (CEC).




Peatlands: an ecosystem containing accumulated, partially decomposed organic matter, under anaerobic and waterlogged conditions.

Spread from arctic to tropical regions, occupying 3% of the earth's land area. More than 90% of all known peatland area is found only in 6 countries (Russia, Canada, USA, Finland, Sweden, and Indonesia).



Why to substitute peat?

Peatlands are highly fragile ecosystems with a great ecological value, representing important carbon dioxide (CO_2) sinks.

The increasing use of peat in horticulture has derived in a quick depletion of wetlands, determining the loss of a non-renewable resource which plays a key role in CO_2 sequestration.




Hence, **environmental concerns** have been increased in order to reduce peat mining and use, and to obtain **sustainable substitutes** as potted substrates.

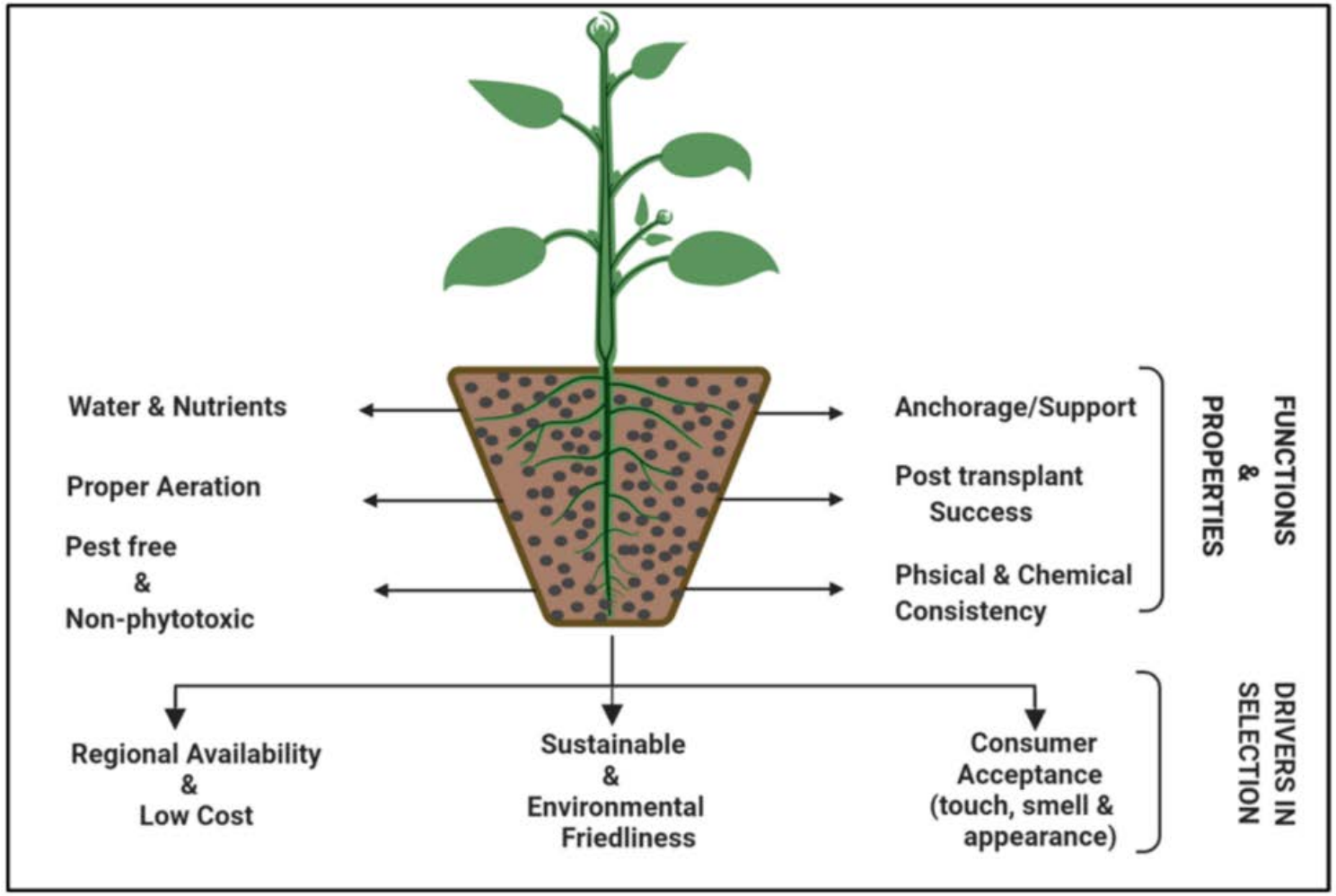
OTHER ORGANIC MATERIALS

* Governmental policies **support** and **encourage** the use of sustainable peat alternatives.
* These materials need to satisfy specific features/properties and be **readily available** in **sufficient quantities** at **reasonable cost**.
* In a worldwide level, many studies are in progress, aiming to find adequate peat alternatives, **without sacrificing plant health and quality**, while trying to take advantage of **organic waste materials**.
* Some organic substrates (**tree bark, coir dust, green wastes-composts, biochars, wood fibers, etc.**) have been tested, **alone or mixed** with inert materials (as perlite) and have been proposed, by different authors, as partial peat substitutes for **vegetables** and **ornamentals**.





CHARACTERS OF AN IDEAL POTTING MEDIA



Agarwal et al, 2021

sustainability

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Article

The Sustainable Use of Cotton, Hazelnut and Ground Peanut Waste in Vegetable Crop Production

Spyridon A. Petropoulos [1,*], Ângela Fernandes [2], Sofia Plexida [1], Carla Pereira [2], Maria Inês Dias [2], Ricardo Calhelha [2], Antonios Chrysargyris [3], Nikolaos Tzortzakis [3], Jovana Petrović [4], Marina D. Soković [4], Isabel C. F. R. Ferreira [2] and Lillian Barros [2,*]

Received: 29 September 2020; Accepted: 9 October 2020; Published: 15 October 2020

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agronomy

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Article

Biochar Type and Ratio as a Peat Additive/Partial Peat Replacement in Growing Media for Cabbage Seedling Production

Antonios Chrysargyris [1], Munoo Prasad [1,2,3], Anna Kavanagh [3] and Nikos Tzortzakis [1,*]

Received: 20 September 2019; Accepted: 23 October 2019; Published: 29 October 2019

check for updates

Environmental Science and Pollution Research (2019) 26:35461–35472
https://doi.org/10.1007/s11356-019-04261-8

ADVANCES & PROSPECTS IN THE FIELD OF WASTE MANAGEMENT

CrossMark

Deployment of olive-stone waste as a substitute growing medium component for *Brassica* seedling production in nurseries

Antonios Chrysargyris [1] · Omiros Antoniou [1] · Filio Athinodorou [1] · Rea Vassiliou [1] · Anastasia Papadaki [2] · Nikos Tzortzakis [1]

Received: 19 September 2018 / Accepted: 15 January 2019 / Published online: 23 January 2019

Environmental Science and Pollution Research (2021) 28:24279–24290
https://doi.org/10.1007/s11356-020-07944-9

WASTE AND BIOMASS MANAGEMENT & VALORIZATION

Check for updates

The use of spent coffee grounds in growing media for the production of *Brassica* seedlings in nurseries

Antonios Chrysargyris [1] · Omiros Antoniou [1] · Panayiota Xylia [1] · Spyridon Petropoulos [2] · Nikos Tzortzakis [1]

Received: 18 August 2019 / Accepted: 29 January 2020 / Published online: 6 February 2020

sustainability

MDPI

Article

Printed Paper Waste as an Alternative Growing Medium Component to Produce Brassica Seedlings under Nursery Conditions

Antonios Chrysargyris [1], Panayiota Xylia [1], Gorkem Akinci [2], Konstantinos Moustakas [3] and Nikolaos Tzortzakis [1,*]

Received: 29 June 2020; Accepted: 17 July 2020; Published: 25 July 2020

check for updates

Waste Management 113 (2020) 469–477

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

ELSEVIER

A biorefinery for conversion of citrus peel waste into essential oils, pectin, fertilizer and succinic acid via different fermentation strategies

Maria Patsalou [a], Antonios Chrysargyris [b], Nikolaos Tzortzakis [b], Michalis Koutinas [a,*]

[a] Department of Chemical Engineering, Cyprus University of Technology, 30 Archbishop Kyprianou Str., 3036 Limassol, Cyprus
[b] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 30 Archbishop Kyprianou Str., 3036 Limassol, Cyprus

Test a wide variety of waste materials

Test mixtures

In different plant species

Ornamental Plants

Clean Technologies and Environmental Policy (2019) 21:1937–1948
https://doi.org/10.1007/s10098-018-1647-7

ORIGINAL PAPER

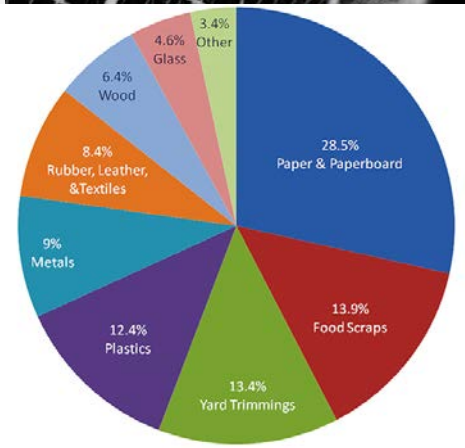
Utilization of paper waste as growing media for potted ornamental plants

Antonios Chrysargyris[1] · Menelaos Stavrinides[1] · Konstantinos Moustakas[2] · Nikos Tzortzakis[1]

Received: 24 July 2018 / Accepted: 15 November 2018 / Published online: 27 November 2018

About 30% of the municipal waste is made up of paper and paper products, so we employed its use as a growing media component for **ornamental plants** (marigold-*Calendula officinalis* L., petunia-*Petunia×hybrita* L. and matthiola-*Matthiola incana* L.).

Peat can be **substituted by up to 30% of for marigold and petunia** (plant height, fresh biomass, number and quality of produced flowers).



Ornamental Plants

agronomy

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Article

Biochar Type, Ratio, and Nutrient Levels in Growing Media Affects Seedling Production and Plant Performance

Antonios Chrysargyris [1], Munoo Prasad [1,2,3], Anna Kavanagh [3] and Nikos Tzortzakis [1,*]

Received: 21 July 2020; Accepted: 16 September 2020; Published: 18 September 2020

check for updates

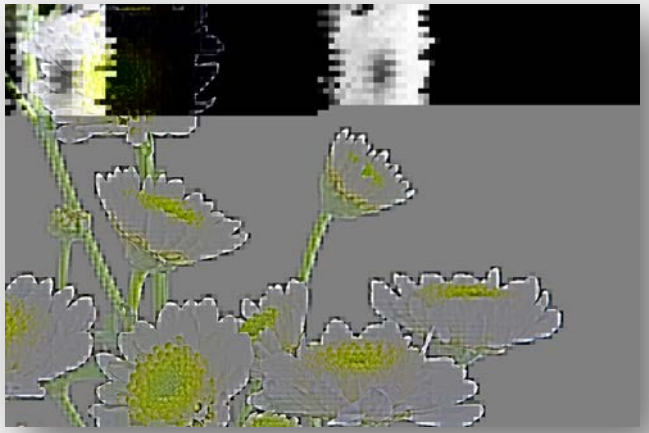
Geranium (*Pelargonium* × *hortorum*), impatiens (*Impatiens walleriana)*

Addition of **7.5% biochar** increased **leaf number and fresh mass**, while a series of other parameters were constant

AIM OF THE STUDY

For this study, two waste materials derived from the production of high value products (**wine and olive oil**) were used, as potential substitutes of peat.

Potted ***Chrysanthemum indicum***, the 2nd top selling flower after roses, was evaluated after cultivation in the produced mixtures



EXPERIMENT

Set up and Analysis

of Substrate Mixtures and Plants

EXPERIMENT DESCRIPTION/CULTIVATION

Material 1

- **Olive oil production wastes (OW)** were collected from the production of a multi-variety olive oil, form the area of Agios Sylas (Limassol, Cyprus), in 2020.
- The material was not composted, and was air dried.
- The waste included the remaining pulp and crushed stones (average, the 80% of the initial olive fruit weight, 30% solid waste)-actual numbers depend on the **variety**, **process** of extraction (2p,3P).

EXPERIMENT DESCRIPTION/CULTIVATION

Material 2

- **Winery wastes (WW)** were collected from a winery in the area of Kanaviou (Pafos, Cyprus), from the indigenous variety of "**Mavro**", harvested from a dry vineyard, during 2019.
- The material was air dried.
- The waste included grape marc, pomace, grape stalks and stems (0.121 kg/0.75 L bottle, Litskas et al, 2020)
- "**Mavro**" is a wide spread variety of vine (~3000 ha), basic component of the dessert Coummadaria wine (the other variety used is the white variety Xinisteri).

EXPERIMENT DESCRIPTION/CULTIVATION

Substrate mixtures preparation

4 ratios **(5%, 10%, 20%, 40%)** of olive oil production wastes **(OW)**

4 ratios **(5%, 10%, 20%, 40%)** of winery wastes **(WW)**

were produced with peat, while **100% peat** was used as **control** treatment

Mixtures were prepared, 5 L pots were filled, plants were transplanted.

EXPERIMENT DESCRIPTION/CULTIVATION

Hydroponic Greenhouse CUT, Limassol, Cyprus

- Plants (***Chrysanthemum indicum*** **"Pina Colada")** were produced from cuttings
- At the stage of 4 leaves, **uniform rooted cuttings** were selected and transplanted into the pots with the mixtures
- 8 replications/pots/treatment
- No additional fertigation or any crop protection product was applied
- Irrigation was applied according to plant needs, from the bottom of the pot
- Duration of Cultivation: **7 weeks**
- T=22,52±0,34 °C, RH=55,50 ± 1,52 %, LD=1580±55 Lux

MEASUREMENTS ON PLANT AND MIXTURES

Plant growth and analysis

- Plant growth parameters (plant height, fresh and dry weight of plant parts-flowers, leaves, shoots, dry matter, number of flowers, number of leaves, stem diameter, number of lateral shoots).
- Physiological properties (Leaf fluorescence Fv/Fm, stomatal conductance, leaf chlorophyll-SPAD).
- Total phenolic and flavonoid content, antioxidant activity of leaf extracts.
- Mineral analysis (N, K, P, Na……analysis is running).
- ***Enzymes activities (SOD, CAT, POD).***
- ***Stress indicators (H2O2, MDA, Proline).***

Mixture properties

- EC, pH, organic matter, total porosity, air filled porosity, bulk density, mineral content analysis *(at the beginning and at the end of the cultivation).*

Chrysanthemum cultivated in olive oil production waste mixtures

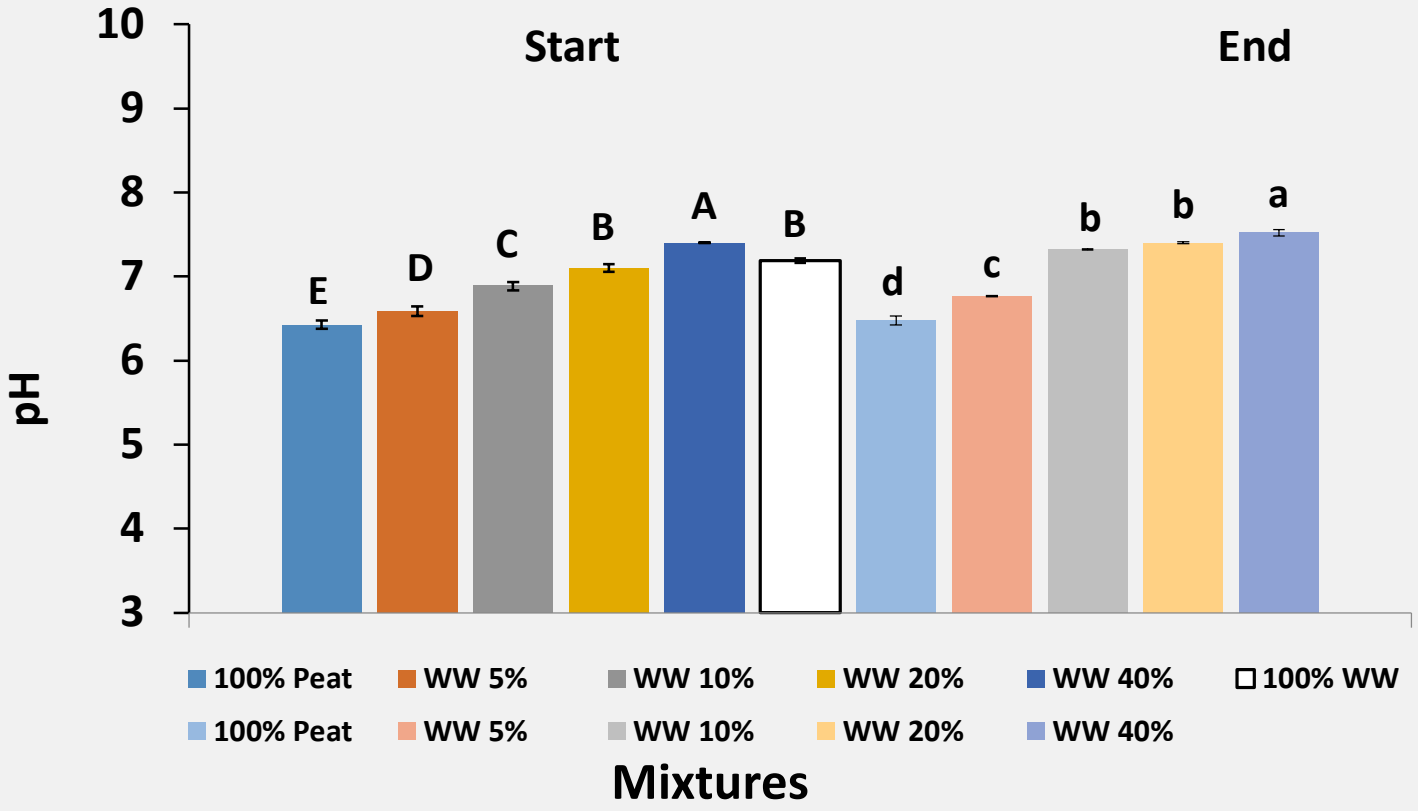
Peat 100% OW 5% OW 10% OW 20% OW 40%

Chrysanthemum cultivated in winery waste mixtures

Peat 100% WW 5% WW 10% WW 20% WW 40%

RESULTS: MIXTURES

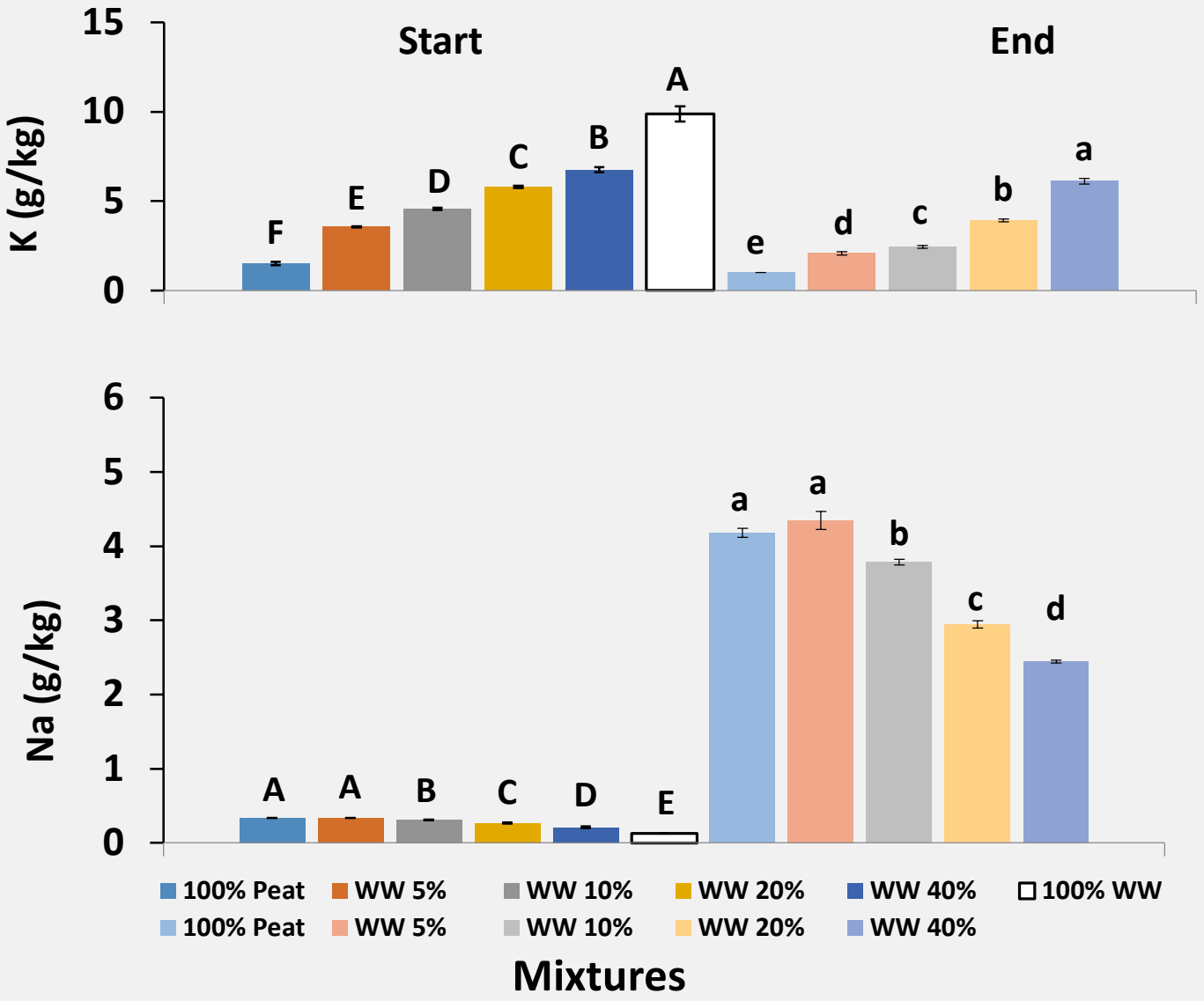
Winery wastes mixtures



Average pH values were at appropriate levels for chrysanthemum cultivation

- pH $_{start}$=av. 6.9 (6.4-7.4)
- pH $_{end}$=av. 7.1 (6.4-7.5)
- *EC=289 µS/cm*
- *EC=487 µS/cm*

Winery wastes mixtures

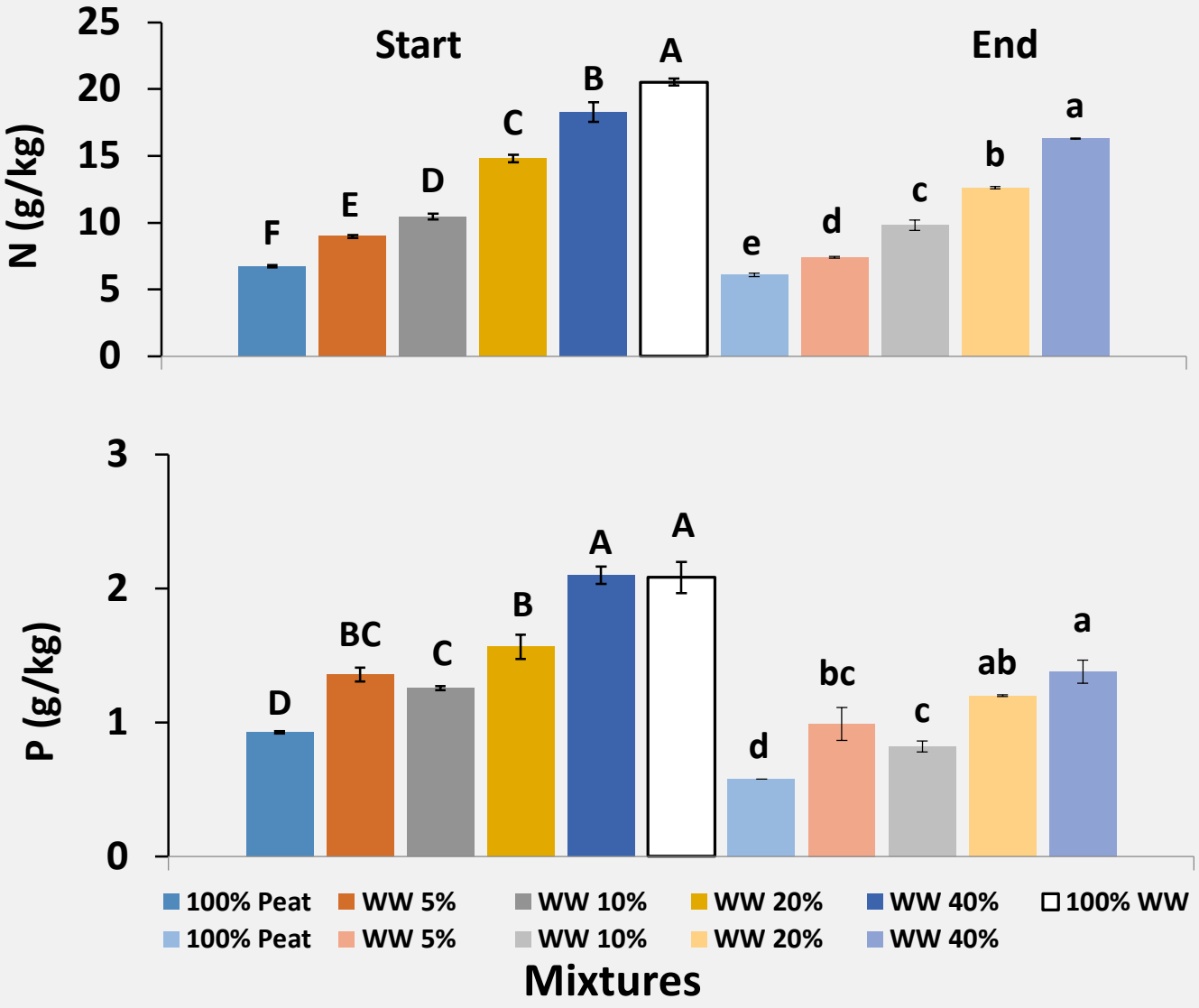


RESULTS: MIXTURES

* K increased along with the % of WW in the mixtures

* Na was accumulated in the mixture at the end of the cultivation

Winery wastes mixtures

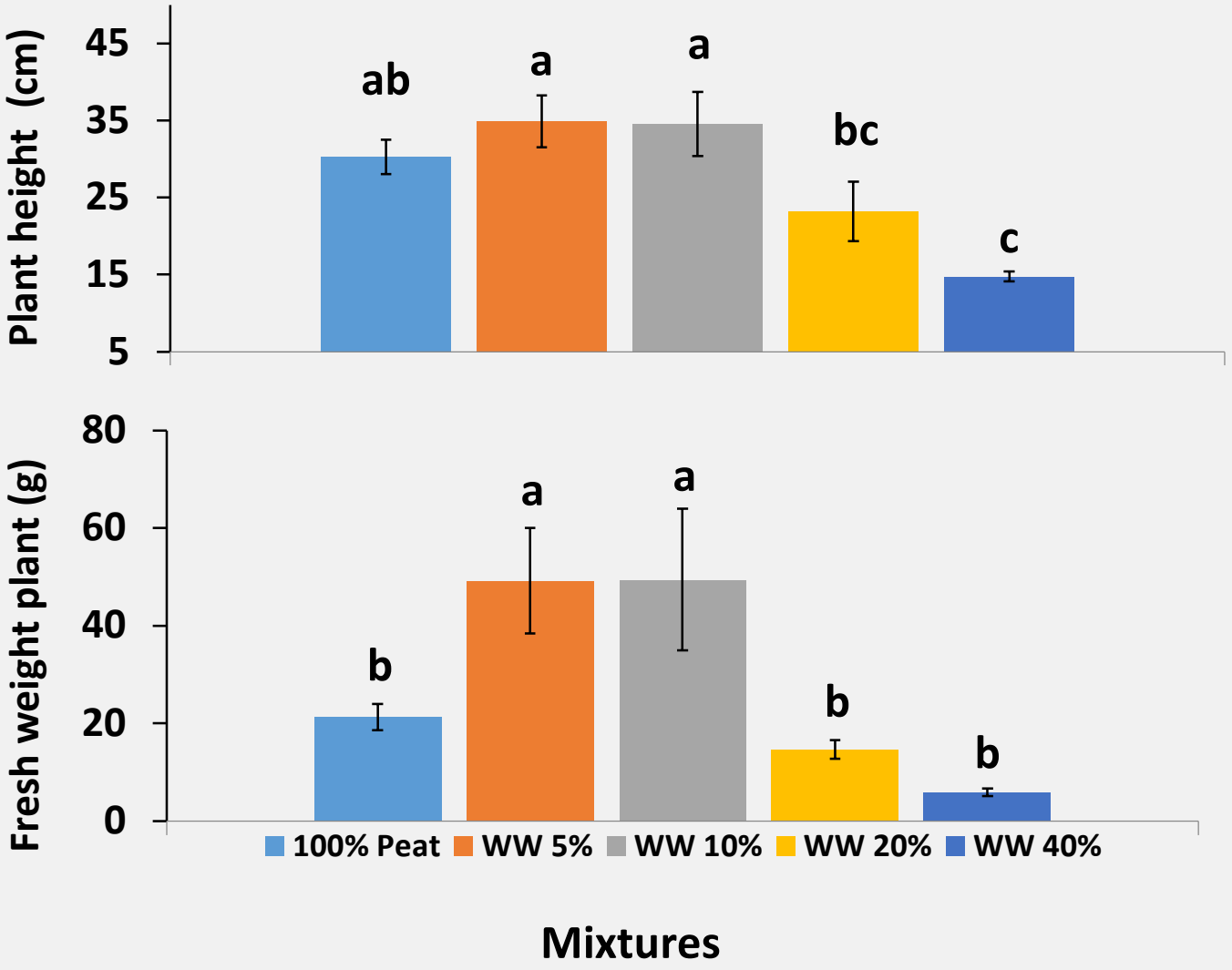


RESULTS: MIXTURES

* N was increased along with the % of WW in the mixtures

* P level varied between mixtures

Plant Growth Parameters-Winery Wastes



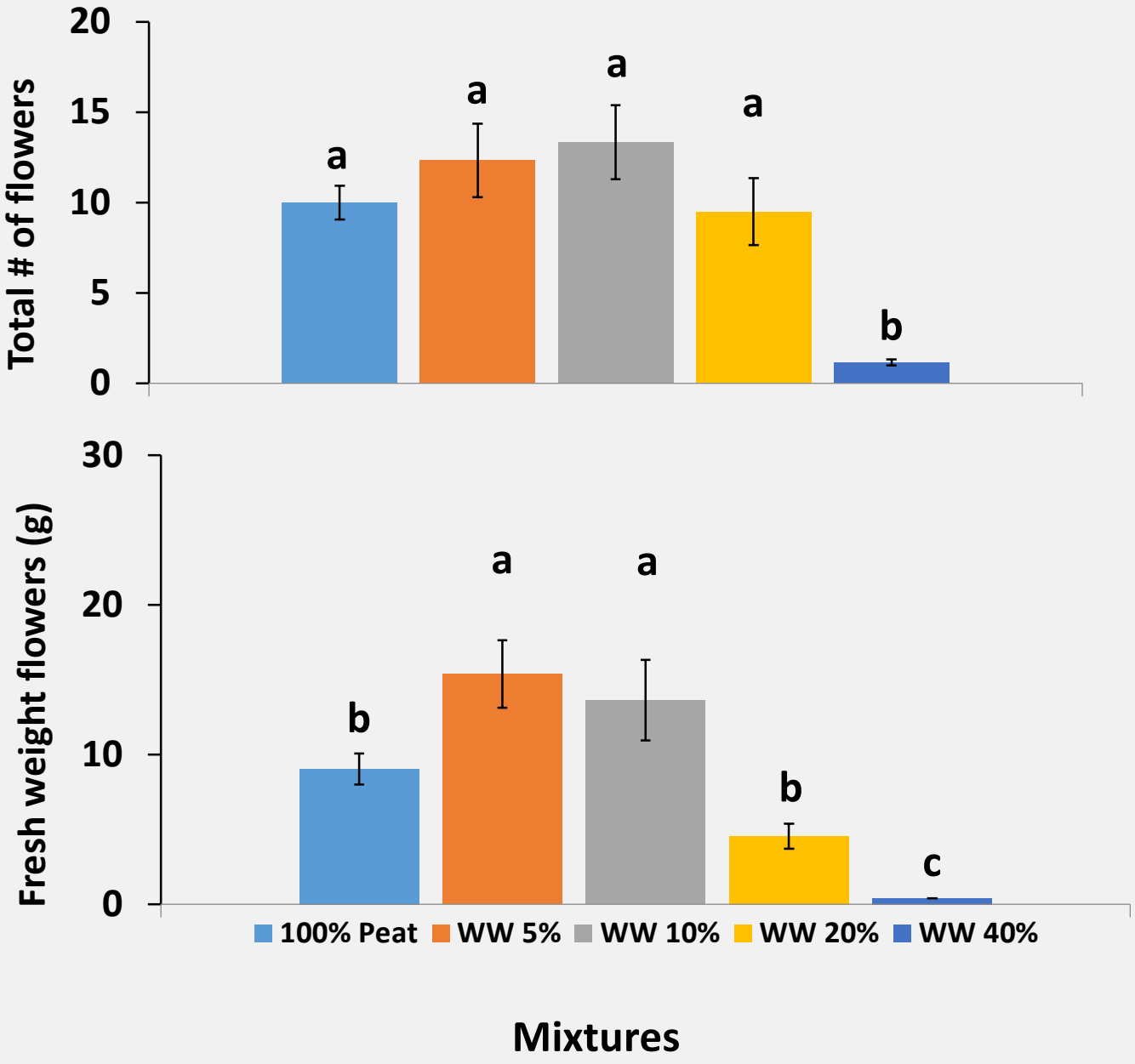
RESULTS: PLANTS

* Tendency for higher plants

* 5 and 10% of WW resulted in increased fresh weight, with increased lateral shoots (2.8 to 6.5).

* (accelerating plant growth and flower production)

Plant Growth Parameters-Winery Wastes

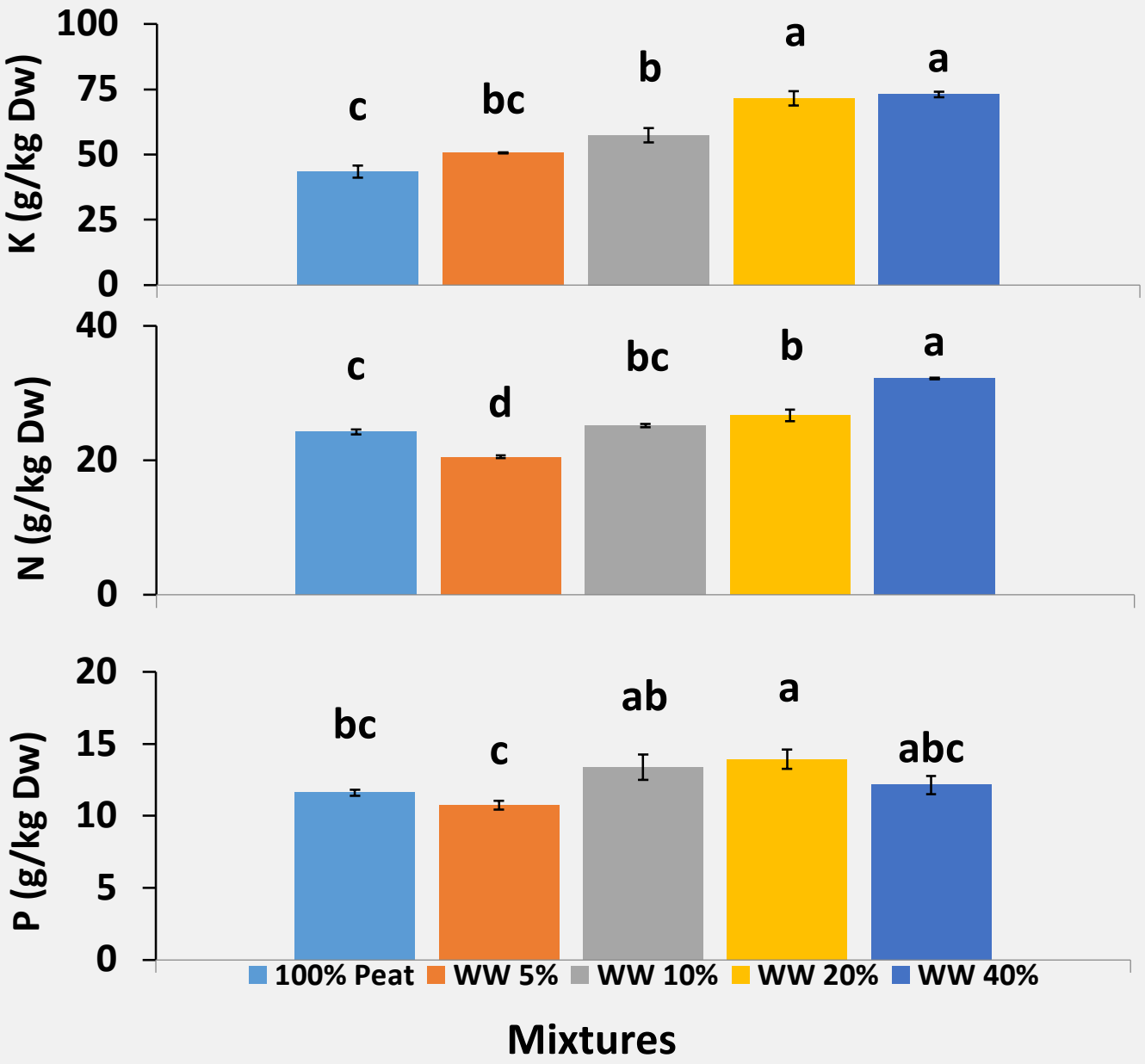


RESULTS: PLANTS

* 5 and 10% of WW resulted in increased fresh weight of produced flowers

* (with a tendency of increased number of produced flowers at 5 and 10% of WW)

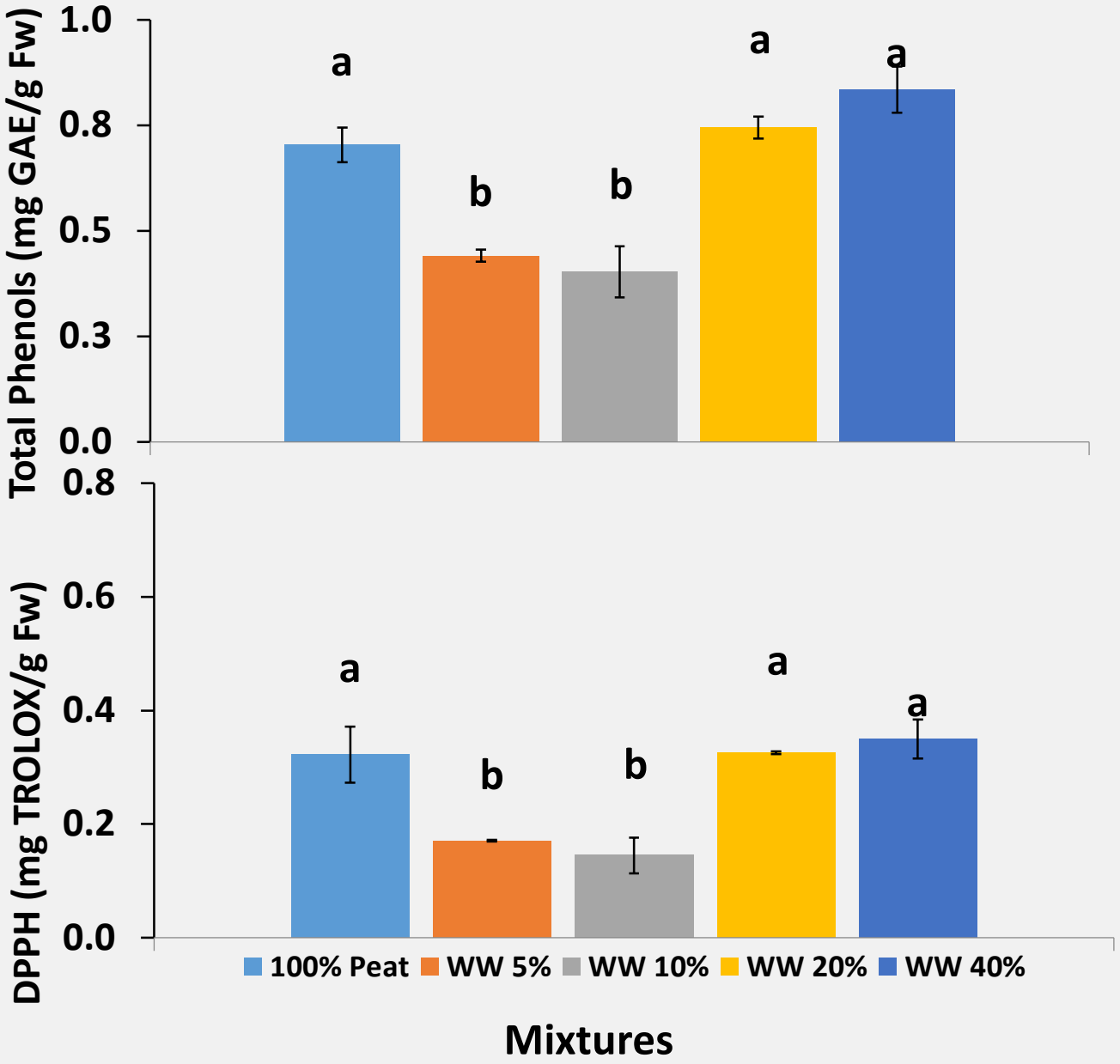
Leaf Mineral Content-Winery Wastes



RESULTS: PLANTS

* K was increased along with the % of WW- as in the mixtures
* N and P were found in lower levels at 5% of WW, and maybe consumed for flower production

Plant Biological Properties/Antioxidant Status-Winery Wastes



RESULTS: PLANTS

* Antioxidant status of the plants cultivated at 5 and 10% of WW, revealed a non-stress condition.
* Plant physiological parameters (stom.cond, Fv/Fm, chl content) were not changed compared to the control (5 and 10% WW).

CONCLUSIONS

- **Winery Wastes** is a **promising material**, as when it is used at **5-10%** in the substrate mixture **with peat**, provides **fully commercial chrysanthemum plants** (potted/cut).
- The produced plants had **increased total fresh mass**, and a tendency for **higher number of flowers**, **accelerating flowering**.
- Plant physiology: plants were **less stressed** at **5 and 10% WW**, compared to the controls (100% peat). Stress indicators and defense mechanism found at lower (antioxidants) or at the same levels (stom.cond) with the control (100% peat).
- A series of other parameters is under analysis.
- **NEXT STEP**: application of additional fertilization (N-K-P)

- *The evaluation of OW as a substrate needs to be continued, using mixtures with other materials and/or additional fertigation.*

Cyprus University of Technology

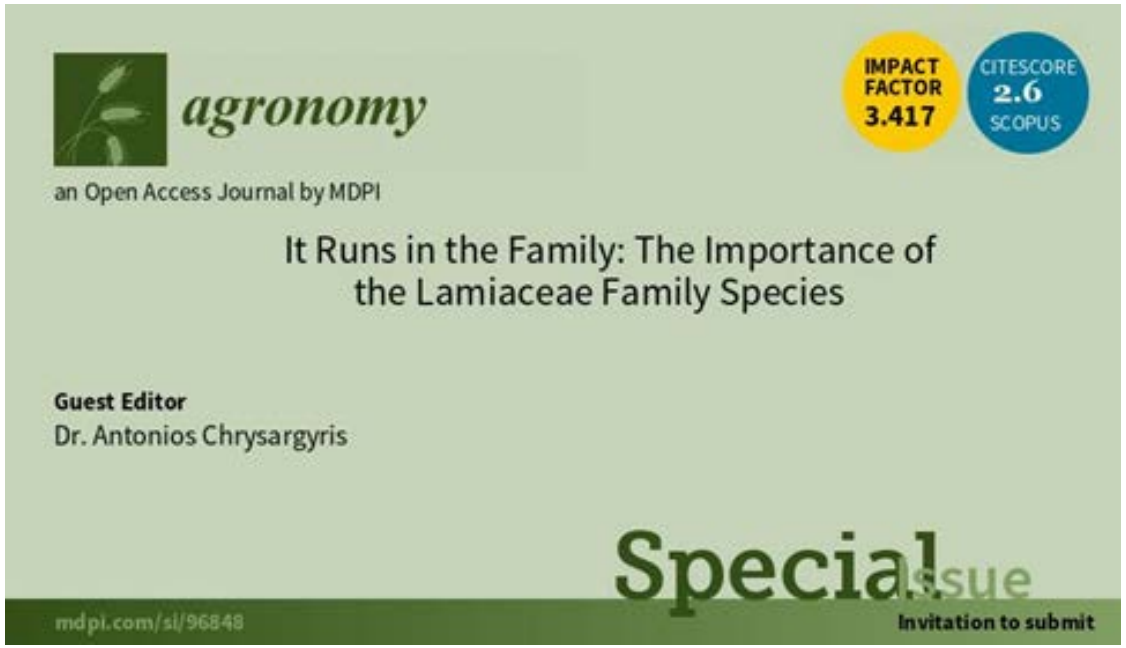
Research Topic

Bio-based Compounds from Plants and Beneficial Microbes for Alleviation of Biotic and Abiotic Stress

frontiers in Plant Science

Quest Editors

Dr. Antonios Chrysargyris, Prof. Aziz Aziz, Dr. Nikolaos Tzortzakis



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HYDRO AROMATIC PLANTS

Thank you

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