

**Wydział Biotechnologii i Ogrodnictwa**  
Katedra Ogrodnictwa

Krakow, 28 January 2022

## **REVIEW OF DOCTORAL DISSERTATION**

**Author: Raghavendra Prasad Mudalagiri, M.Sc.**

## **EDUCATION OF CANDIDATE**

Aug 2015 - June 2017 M.Sc. Horticulture  
University of Agricultural and Horticultural Sciences, Karnataka, India  
Specialization: Pomology

Aug 2011 - April 2015 B.Sc. Horticulture  
University of Horticultural Sciences, Bagalkot, Karnataka, India

June 2009 - Dec 2009 Diploma in computer application  
Manipal Institute of Computer Education, Tumkur, Karnataka, India

## **INFORMATION ON CANDIDATE'S FORMER APPLICATION FOR PhD DEGREE**

According to the attached CV, Raghavendra Prasad Mudalagiri, M.Sc. haven't applied for PhD degree former.

## **WORK EXPERIENCE OF CANDIDATE**

According to the attached CV, Raghavendra Prasad Mudalagiri, M.Sc. has not presented temporary or steady job experiences. He mentioned wide spectrum of teaching, research extension, traineeship, technical, IT, leadership, etc. activities.

## **TITLE OF PRESENT DISSERTATION**

**The spent mushroom substrate as a growing medium for strawberry (*Fragaria × ananassa* Duch.)**

## **THE GENERAL EVALUATION OF DISSERTATION ARRANGEMENT AND AIMS OF CANDIDATE'S RESEARCH**

Strawberry (*Fragaria × ananassa* Duch.) is one of the most delicious and fragrantly sweet-flavored fruits of the world, very popular in many countries due to its unique taste, nutritional, and health benefits. Therefore, developing modern methods to increase strawberry's yield and quality can play an essential role in improving plants' overall performance. The specificity of the growing medium is a crucial factor in the cultivation technology of dessert fruits. In sustainable agriculture, reutilization of organic wastes, including the spent mushroom substrate, has significant environmental and economic



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importance. Since Poland has been a leader in white bottom mushroom production, sustainable management of spent mushroom substrate has become a crucial ecological problem. Based on the current state of knowledge regarding the technology of strawberry production, Raghavendra Prasad Mudalagiri chose as a goal of his dissertation to evaluate the yield and quality of two strawberry cultivars grown in a substrate composed of spent mushroom substrate of different origin and peat. In my opinion, the topic is novel and scientifically crucial for a wide range of both cognitive and practical perspectives.

The doctoral dissertation by Raghavendra Prasad Mudalagiri is a clearly written and well-organized monograph. The title corresponds to the presented findings. Raghavendra Prasad Mudalagiri hypothesized – according to my interpretation of objectives of the dissertation – that (i) it is possible to utilize spent mushroom substrate as a substitute for peat in strawberry cultivation, (ii) the performance of strawberry depends on the cultivar and composition of the spent mushroom substrate, (iii) it is possible to determine the composition of the spent mushroom substrate and peat the most suitable for soilless strawberry production. In order to verify these hypotheses, the Author planned and performed a series of three experiments that confirmed the veracity of the assumptions and allowed him to achieve the goals of the thesis and formulate precise conclusions. Realization of research tasks, allowed the Author to accumulate comprehensive experimental and bibliographic material, which was compiled in the form of a monograph. The dissertation's arrangement is typical; the monograph consists of nine main chapters (127 pages), of which the most comprehensive and most important is the *Results* (35 pages). The dissertation is written in English, while an additional Polish *Summary* is included as the 9<sup>th</sup> chapter.

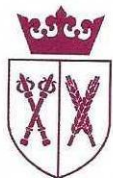
## **THE DETAILED EVALUATION OF DISSERTATION ARRANGEMENT AND SUBSEQUENT CHAPTERS**

### **The evaluation of the *Introduction* chapter**

In the first chapter of the dissertation, *Introduction*, the Author cogently explained the scientific background, including possible advantages and risks of using the spent mushroom substrate in strawberry production. Anyway, in my opinion, the research objectives are formulated in a too general manner and don't reflect the wide range of investigated parameters. Some formulations are not scientifically clear, for example, "to study the possibility" – how "the possibility" was evaluated? "will be the most suitable" concerning which substrate/plant parameters? My advice is to precise the objectives of the study in the following original papers. Another aspect is that the research objectives should arise from the literature review, so they should be formulated at the end of the *Review of literature* chapter.

### **The evaluation of the *Review of literature* chapter**

The second chapter, entitled *Review of literature* (16 pages), explains the importance and novelty of the investigations in the context of up-to-date trends in recent international research. First subchapter (2.1) focuses on the origin, biology, and health benefits of strawberry. The following subchapter (2.2) describes techniques of soilless strawberry production. The Author linked main substrate characteristics, namely EC, pH, and nutrient content, with strawberry plant and fruit parameters and physiological indicators reflecting the plant's fitness (subchapters 2.4.1-2.4.3). In my opinion, the weakness of these subchapters is



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the lack of description of strawberry's demands concerning substrate physical characteristics and mineral nutrition during subsequent stages of vegetative growth and harvesting period. Primarily, recommendations on macro- and microelement's nutrition were described relatively briefly. However, the Author stated that "the nutrient content in growing media plays a crucial role in plant growth and development". The title of subchapter 2.4.3. doesn't reflect the essence of this paragraph (maybe "Main indicators of strawberry plant's performance" sounds better). That's why my recommendation is to separate sections focused on strawberry demands *versus* recommendations for soilless cultivation and stress factors *versus* techniques of their measurement.

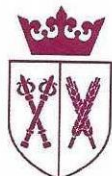
The Author presented the state of knowledge on possibilities of use agro-wastes as growing substrates (subchapter 2.6) focusing on spent mushroom substrate and peat mixes (subchapters 2.7-2.13). This is reasonable in the light of performed research. The Author deeply characterized hazards and opportunities arising from spent mushroom substrate's application in agriculture. My main comment is the lack of precise data on spent mushroom substrate physical and chemical characteristics and the effect of composting on these values. If available, the Author should replace vague adjectives like 'lower', 'higher', etc., with quantifiable values.

Overall comments: *Review of literature* clearly describes a scientific background and the current state of knowledge in the field of investigations. This chapter has thoughtful layout and high merit value, which proved the Author's skills in utilizing the world's scientific literature. The *Review of literature* is not just a collection of bibliographical material on strawberry and growing media used in its production in recent decades, but also the selection and critical analysis of reports by various researchers. The *Review of the literature* in this area provided the scientific basis justifying the correct choice and application of specific cultivation methods and physiological analyses used by the Author in an experimental design.

**The evaluation of the *Materials and method* chapter**

The third chapter, *Materials and method*, consists of 28 pages. This chapter comprises six tables, two figures, and eighteen photos of experiments. The Author described precisely the research material and methods used to allow repetition of the work. The experimental design is appropriate, the control was included, and the nomenclature was correctly used. The Author investigated six substrate combinations (and 100% peat as a control). The origin of substrate components, methods of preparation, growing conditions, cultivation procedures, observations, and measured parameters were described correctly and comprehensively. As plant materials, the Author selected two strawberry cultivars. However, the selection of experimental cultivars should be justified by different origins, climatic requirements, yield dynamics, characteristics of fruits, tolerance to pests and diseases, etc.

Experimental layout enabled the collection of results to verify the research hypotheses and achieve the research goals. Moreover, the applied methods allowed for obtaining both scientific and practical results. The Author analyzed a broad spectrum of substrate characteristics, including samples collected before and after the experiments. Although strawberry's morphological parameters were analyzed comprehensively (anyway, there's a need of explanation how particular parameters were measured, for example, plant height, shoot length, plant diameter) but fruit analyses were selective and covered only fruit diameter, weight, soluble solids content, colour, and yield parameters. There is a lack of biochemical analysis of fruit composition, i.e., antioxidant activity (widely described in *Review of*



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*literature*), or mineral elements content which is crucial for fruits quality and could be linked directly with mineral load and availability in substrates. Anyway, the proposed experimental arrangement allowed for assessing the significance of differences between cultivars and substrates, but the description of the method of statistical analysis is missing. It should be supplemented in perspective, original scientific publication.

Overall comments: The Author used a wide range of research methods, generally appropriate to the aims formulated in the dissertation. However, the implementation of parameters defining fruits quality could be valuable for a comprehensive analysis of the effect of substrate composition on fruits' biochemical composition.

**The evaluation of the *Results* chapter**

The fourth section, *Results*, presents the data collected from three main experiments and consists of seventeen main subchapters, including eighteen tables and ten figures. The volume and quality of experimental results are sufficient for a successful dissertation.

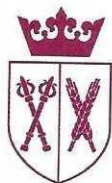
My questions are as follows:

1. Why did Author present mean values of substrate parameters for three years of the experiment? Spent mushroom substrate parameters vary even among growing cycles, so these parameters can influence differently the substrate and plant characteristics in three experimental years. I'll be grateful for an explanation.
2. Significance of differences between substrate parameters. The Author included only mean, maximum and minimum values (chapters 4.1) or (probably) means of analytical repetitions (chapter 4.2) without standard error, standard deviation, or other statistical evaluation. That's why the interpretation of the results is based on speculations. I recommend supplementing this part of the results with fundamental statistical analysis before elaborating a manuscript for publication in a scientific journal.
2. Repetition of most values presented in tables in the text. This manner is not acceptable in scientific journals or dissertations.
3. Lack of consequence in result description. For example, in chapter 4.1.2., there's no comment on the concentration of P, Cl, Fe, Mn, Cu. Please, explain.
4. Chapter 4.1, last paragraph "Overall, the results..." 4.2.1. "The chemical analysis...", whole chapter 4.2.3. should be included in the *Discussion* because these are rather conclusions, speculative, and not confirmed statistically. The Author compared experimental results with characteristics of commercial peat, although the last was not supported by proper references.
5. All Tables and Figures should be supplemented with the explanation of abbreviations used (S1-S7, MY, LA, SDW, RDW, and TPDW) to be readable as separate parts of the thesis.

Overall comments: The Author demonstrated broad knowledge on the critical selection of data for statistical analysis to demonstrate significant differences between plant parameters and correlations between plant characteristics.

**The evaluation of the *Discussion* chapter and practical applications**

The *Discussion* is an essential chapter because it allows for discussing the results in light of the current knowledge in substrate characteristics and morphology, yield, and physiology of strawberry cultivars. A difficult task, especially for a young scientist, is to generalize, explain and support the present results with the world literature. The Author



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clearly elaborated this chapter; the subchapters were consistently arranged in a scheme uniform to the whole manuscript, allowing for a comfortable analysis of Author's considerations. The Author discussed the yield potential of strawberry cultivars concerning substrate formulations on the background of world literature.

My comments concern the first paragraph of chapter 5 and first paragraph of subchapter 5.1 of *Discussion* is the repetition of quotes from *Review of literature*, and is referenced by literature cited previously in *Review of literature*, so it should be deleted. The first paragraph of subchapter 5.1 is also the review of literature. Concerning the remaining parts of the Discussion, I value the influential Author's effort to discuss the results with references cited, and I found a proper manner in this case. I estimate chapter 5.8 as one of the most valuable because this subchapter exposed the utilitarian and scientific value of the thesis.

The *Conclusions* were compiled as three main points supplemented with *General remarks and future recommendations*, which were a sound, accurate, and exhaustive summary of the results obtained.

The seventh chapter, *References*, consisted of 247 items, primarily original research papers of international coverage, relevant to the topic of the dissertation. I can assume that the Author's orientation regarding the advancement of research is broad in terms of the latest state of knowledge.

The 8<sup>th</sup> and 9<sup>th</sup> chapters of the thesis are English and Polish *Summaries* covering the state of knowledge in the fields relevant to the dissertation topic, with a statement of the goals, main methods, results, and conclusions.

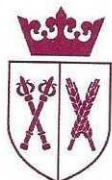
**THE EVALUATION OF MAIN ACHIEVEMENTS, NOVELTY, AND ORIGINALITY OF RESEARCH**

I must admit that I read the dissertation with great interest because of the novel research problem, scientific quality, and extraordinary editorial diligence. In my opinion, the dissertation is very valuable in terms of methodology and elaboration. I want to point out only a few of the most significant achievements of Raghavendra Prasad Mudalagiri's dissertation.

The strengths of this dissertation are (1) current and innovative topic of the research, which allows for the publication of results in journals with a high impact factor; (2) assessment of the morphological, physiological, and yield potential of strawberry with recommendations for the production in particular substrate formulations based on the spent mushroom substrate; (3) analysis of substrate formulations, allowing to specify those features that are most effective in strawberry cultivation; (4) scientific and practical significance of the results.

**GENERAL OPINION AND DECISION**

In light of the above, I positively evaluate the dissertation 'The spent mushroom substrate as a growing medium for strawberry (*Fragaria × ananassa* Duch.)' by Raghavendra Prasad Mudalagiri. The dissertation fulfills substantial and formal requirements of a doctoral thesis under Article 187, ACT of 20 July 2018 The Law on Higher Education and Science (Journal of Laws of 2020, item 85, as amended). The doctoral dissertation by Raghavendra



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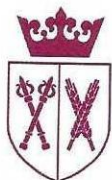
Prasad Mudalagiri is a monograph that demonstrates the candidate's general theoretical knowledge in a discipline and the ability to conduct research work independently. The subject matter of the doctoral dissertation is an original solution to a scientific problem or in terms of the application of results of own scientific research. The Author proved her creative abilities, demonstrated a general knowledge of the chosen discipline, and conducted independent research by himself.

Therefore, I express my **POSSITIVE** opinion on the present dissertation and I request to approve Raghavendra Prasad Mudalagiri 's dissertation to further the conferment procedure for a doctoral degree.

Agnieszka Sękara, Associate Professor  
Department of Horticulture  
University of Agriculture in Krakow  
29 Listopada 54, 31-425 Kraków, Poland

Detailed comments:

- Page 10, chapter 2.1. – correct citation is 'Darnell et al.', see page 105
- Page 11, chapter 2.4.1. – correct citation is 'Latigui', see page 112
- Page 11, chapter 2.4 – the titles of subchapters are not clear. Please, consider the use of full sentence, for example "The effect of substrates on vegetative, generative and quality parameters of strawberry"
- Page 13, chapter 2.4.2. – correct citation is 'Saied et al. 2005', see page 119
- Page 13, chapter 2.4.2. – EC of 2.73 – consequently the unit should be supplemented
- Page 13, chapter 2.4.2. – 'photosynthetic capacity' seems to be wrong term; it should be replaced with 'antioxidant capacity'
- Page 15, chapter 2.5. – correct citation is 'Dhen et al.', see page 106
- Page 16, chapter 2.6. – correct citation is 'Dhen et al.', see page 106
- Page 17, chapter 2.6. – Amieri et al.... (50:50)...Please supplement % by weight or volume?
- Page 18, chapter 2.6 – correct citation is 'Latigui', see page 112
- Page 20, chapter 2.7.2 – correct citation is 'Ahlawat et al.', see page 101
- Page 20, chapter 2.7.2 – correct citation is 'Gonzales-Marcos et al.', see page 108
- Page 21, chapter 2.8 – correct citation is 'Gao et al.', see page 107
- Page 21, chapter 2.8 – correct citation is 'Ahlawat et al.', see page 101
- Page 23, chapter 2.11 – 'The soils amended with SMS....higher yield' soil can't show higher yield
- Page 23, chapter 2.11 – correct citation is 'Gobbi et al. 2016'
- Page 24, chapter 2.12 – correct citation is '(Demir 2017)', see page 106
- Page 25, chapter 2.13 – correct citation is '(Demir 2017)', see page 106
- Page 54, chapter 4.1.1. – pH range for A-SMS mentioned in the text should be 7.93-8.46
- Page 57, chapter 4.2.2.2. – correct value in the sentence "...Fe was higher in S7" is 110.2.



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Chapter 4.2.2. – instead 'higher', in most cases should be 'the highest'

Chapter 4.2.2.3., Line 4 – C1 was not determined

Chapter 4.2.2.3., Line 5 – Fe was higher also in S4 and S5, Mn and Zn in S2-S5, but I cannot state if these differences were statistically significant.

Chapter 4.7.2. - correct value in the sentence "...greatest fruit diameter..." is 37.97.

Chapter 4.14.2. – instead, Tab. X. should be Tab. 24.

Chapter 4.14.2. – correct values in the sentence "The highest unmarketable yield... are 30.50, 29.98 and 22.34.

Chapter 4.15.2. – the value for S3 in the sentence "The percentage of marketable yields..." does not correspond with Figure 9.

Page 89, chapter 5 – correct citation is '(Demir 2017)', see page 106

Page 94, chapter 5.5. - correct citation is '(Wang and Lin 2002)', see page 122

Page 94, chapter 5.5 – correct citation is 'Latigui', see page 112

Page 94, chapter 5.5, paragraph 'Marketable yield' – in the first sentence it should be supplemented that the values refer to cultivar 'Elsanta'

Page 94, chapter 5.5, paragraph 'Marketable yield' – correct citation is '(Demir 2017)', see page 106

Page 117, chapter 9 – correct citation is 'Philippoussis'

Page 102, chapter 9 – correct citation is 'Auriga... 2020'

General comment – the language should be corrected by a native speaker.