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Review

Review of the doctoral thesis of Gregorio Padula, M.Sc. entitled "Effect of selected factors on seed storage of Welsh onion (*Allium fistulosum* L.)", written under the scientific direction of prof. dr. hab. Roman Hołubowicz.

Commissioned by the prof. UPP dr hab. Piotr Rybacki Chairman of Scientific Council of Discipline Agriculture and Horticulture, the Poznań University of Life Sciences, dated 18 November 2024.

Mr. Gregorio Padula obtained MSc. Science and Animal Technology on July 26, 1991 at the Bologna University Department of Agricultural Sciences (Italy).

The Candidate completed the PhD Studies programme in English at the Poznań University of Life Sciences PhD Studies (PULS Ph Studies) in the field of agricultural sciences, the discipline of agriculture and horticulture.

Work experience: from 1995 to 1998, fruit and vegetable quality assurance and control technician, company CONAD supermarkets; from 1999 to 2008 vegetable seed production manager, company Cooperativa Agricola Cesenta (CAC); from 2008 Managing Director company Tokita Sementi Italia.

Training: from 1993 to 1995, research activity pursued at ERSO (experimental institute operating in vegetable and fruit research).

Gregorio Padula's M.Sc. dissertation falls into the category of a set of articles and consists of three papers:

1. Padula G., Xia X., Hołubowicz R. Welsh Onion (*Allium fistulosum* L.) Seed Physiology, Breeding, Production and Trade.
2. Padula G., Xia X., Szopińska D., Hołubowicz R. Effect of air temperature and relative humidity on the stored Welsh onion (*Allium fistulosum* L.) seeds.
3. Padula G., Macovei A., Ravasio A., Pagano A., Jr Dueñas C., Xia X., Hołubowicz R., Balestrazzi A. Exploring Reactive Oxygen Species Accumulation in *Allium fistulosum* L. Seeds Exposed to Different Storage Conditions.

The articles forming the dissertation have been published in English and scientific journals of international scope. The papers were placed in journals, achieving a significant position in the rankings of the Journal Citation Reports (Notulae Botanicae Horti

Agrobotanici Cluj-Napoca, Seeds and Plants). The articles are preceded by an introduction, which synthesises the project objectives, describes the research methods and discusses the results obtained. The dissertation also contains short abstracts of the published articles. The dissertation is summarised with concluding remarks and conclusions from the results. These are well formulated and fully documented by the collected research material.

In the articles forming the essential core of the dissertation, Gregorio Padula, M.Sc., is the first author, which customarily indicates a leading role in their preparation. It is also confirmed by the co-authors' statements in the publications, which leave no doubt that the Doctoral Student's contribution to the dissertation is significant. In particular, his contribution consisted of his participation in the creation of the research concept, the conduct of all field and laboratory studies and the preparation, under the supervision of the supervisor, of the publication manuscripts. The very form of the dissertation is a good prognosis for the future and testifies to the good preparation of the Doctoral Student for independent research work in today's realities.

All the papers are thematically coherent and provide a solid analysis of the physiological and molecular mechanisms influencing the longevity of the seeds of the Welsh onion (*Allium fistulosum* L.), which have not been studied in this respect before. This fact fully exhausts the statutory requirement for doctoral dissertations of an "original solution to a scientific problem". The Doctoral Student has adopted a correct and expedient research strategy. Namely, in an article of a review character, based on literature data, he presented in detail the issues related to seed production of Welsh onion. He drew attention to the directions of plant breeding, the implementation of which should favour modern agricultural production. Significant progress of the Doctoral Student can be seen in subsequent articles, as the last chronological article is already a mature work, both in terms of the methodological side and interpretation of results. The sophisticated statistical analyses that assist in interpreting the results deserve to be emphasised.

The Doctoral Student brings many new elements to the research, including a mycological analysis of the seeds, determining the level of reactive oxygen species in the seeds and analysing the effect on germination capacity. In addition to their cognitive value, the research enables further improvement of seed storage technology for Welsh onion, which until recently had not been carried out on a commercial scale in Poland. A novel and significant scientific achievement demonstrated in the articles was the issue of costs closely related to temperature and humidity during the long 30-month storage of seeds. Such extensive and long-term research demonstrates Gregorio Padula's M.Sc., great determination and inquisitiveness, which should be considered a highly desirable trait for a researcher and scientist. The research results on the storage costs of Welsh onion seeds at different temperatures have not been previously reported in the literature, so the Candidate's achievement should be considered a pioneering one of significant cognitive and applied value.

The publication of the work in the form of full-fledged articles in recognised professional journals also means that they have passed the dense sieve of the review process, assessing both the methodological workshop and the accuracy of the interpretation of the results, which does not leave the next reviewer with too much room for discussion and polemics. In the remainder of this review, I will focus on the appropriateness of the choice of research topic and the research strategy adopted.

Undoubtedly, the Doctoral Student has chosen to deal with a field experiencing intensive development in recent years. This is because high-quality seed is a direct vehicle for progress and influences production results. Seed quality can be understood very narrowly and defined as the ability to germinate under laboratory conditions or to emerge under field conditions. Nevertheless, it can be understood more broadly, including the variety's genetic value and economic suitability. The biological characteristics of the seed determine its value. On the one hand, this involves, among other things, problems of genetic properties and morphology of the mother plants; on the other hand, it concerns the issue of climatic, soil, and agrotechnical conditions during the seed-growing period. A critical point in seed production is seed storage, which requires strictly defined air temperature and humidity conditions. The latter problem led to the research of Gregorio Padula, M.Sc., who analysed selected Welsh onion genotypes regarding their seed biology under long storage conditions using a modern research technique. Thus, the dissertation is located on the borderline of disciplines, which, in my opinion, significantly increases its value, and the PhD Student skilfully navigates both the layer concerning plant biology and the complex issues of physiological and molecular mechanisms affecting seed longevity.

I consider the very choice of the Welsh onion as the species under study to be an excellent idea. The Author adequately justifies the choice of genotypes for the study guided by important indicators, i.e. the place of seed reproduction and the genetic background, to take into account the influence of parents on seed quality. Unfortunately, neither in the introduction nor in the reference works included in the dissertation did I find a complete description of the functional traits of the selected 13 genotypes for the study. It would have been interesting to have information on yield, frost hardiness, or position in cultivation, as the Author did in article 2, in which He characterised only 4. genotypes. Some of the genotypes studied, such as those coded 18stc35, 270446, 270341, 261286, and 270322, are hybrids, and this would be an interesting starting point to trace, for example, the question of their suitability for commodity cultivation. Understandably, the comprehensive analysis of seed biology planned by the PhD Student could only be done for the primary purpose of the work, i.e. the quality of the seeds during extended storage. Of course, this is my polemical remark because in science, each researcher builds a research workshop for himself, and then it becomes apparent whether the prediction model he created provides a better insight into economic reality.

I picked up a minor inaccuracy in article #2, Effect of air temperature and relative humidity on the stored Welsh onion (*Allium fistulosum* L.) seeds', the genotype 170403214(BO12a) is described as a hybrid variety, while in the description the same genotype is described as a open pollinated cultivar. This inaccuracy remains without significance for the value of the dissertation. I have no further comments on the work submitted to me for review.

The main achievements of the work of cognitive and practical importance include:

- Author's conception of technology for extended seed storage of 14 Welsh onion genotypes;
- determination of optimum conditions for air temperature and humidity and seed moisture, which have the effect of prolonging storage life and inhibiting the development of microflora and pests;
- indicating that laboratory tests can be used to assess the maximum germination potential of seeds, thereby obtaining information on the seed's suitability for sowing;
- demonstrating the relationship between germination capacity and levels of reactive oxygen species ROS in Welsh onion seeds under specific conditions during 12 and 22 months of seed storage;
- carrying out seed health tests and determining the species composition of fungi colonising the seed surface concerning air temperature during storage: genus *Penicillium* spp. and *Phoma* spp. at 7-8 °C, genus *Cladosporium* spp. and *Fusarium* spp. at 25 °C;
- determination of suitable parameters for reduced temperature and absolute humidity to guarantee the preservation of high seed quality over long storage periods concerning electricity costs

In summary, I conclude that the peer-reviewed doctoral thesis of Gregorio Padula, M.Sc., entitled. "Effect of selected factors on seed storage of Welsh onion (*Allium fistulosum* L.)":

- makes a significant contribution to the development of agricultural science
- I consider the thesis to be entirely innovative and a significant research achievement due to the complexity of the subject matter, the clearly defined objective and the complete, consistent and comprehensive implementation of the objective;
- represents an original solution to a scientific problem. The results obtained are of high cognitive and utilitarian value;
- brings many new elements which, in addition to their cognitive value, make it possible to improve seed storage methods further;
- properly collected literature, the completeness of results and their correct interpretation testify to the diligence and maturity of the Author of the dissertation. Undoubtedly, the Doctoral Student has duly decided to tackle a problematic research problem and has fulfilled the task undertaken, and the dissertation is a valuable original contribution to science and practice;

- it demonstrates that he or she has the skills to conduct independent research and direct research.

Given the above, I conclude that the thesis presented to me for review meets the statutory requirements for doctoral dissertations (Act of 14 March 2003 on scientific degrees and academic title and degrees and title in art (Dz. U. no. 65, pos. 595 as amended) and the Regulation of the Minister of Science and Higher Education of 03 November 2014 on the detailed procedure for carrying out activities in doctoral and postdoctoral dissertations and in proceedings for the conferment of the title of professor (Dz. U. poz. 1383) and **I am applying to the Scientific Council of Discipline Agriculture and Horticulture, the Poznań University of Life Sciences, to admit Gregorio Padula, M. Sc. to further stages of the doctoral dissertation.**

A handwritten signature in blue ink, consisting of a large, stylized initial 'G' followed by several vertical strokes and a horizontal line, likely representing the reviewer's name.

