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ORIGINAL RESEARCH PAPER

MORPHOLOGICAL CHANGES DURING GERMINATION AND GROWTH OF RAPESEED SAMPLES (*Brassica napus*) EXPOSED TO NON-IONIZING RADIATION

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Abstract: The UV-A radiation acts on cellular constituents indirectly through oxidative mechanisms involving the radicals' formation. These species have a relatively short lifespan, but are highly reactive, reacts with most cellular constituents: nucleic acids, proteins, lipids, polysaccharides.
The rapeseed samples provided by Agricultural Research Center Secuieni, Neamţ (Romania) were irradiated with a wide band source (UV-B, UV-A, visible) with different non-radiation doses, equivalent to several hours of sun exposure. The exposure to UV radiation determines changes in the metabolism, within the growth and development processes, having positive or negative influences on plant health and vitality.
The purpose of this study is to analyze different rapeseed samples in order to identify the differences according to non-radiation effect. Regarding the growth and development of height stems it has been observed that roots length and stem height of rape samples are highest at irradiation time around 280 minutes.

Keywords: *irradiation, non-ionizing electromagnetic radiation, rapeseed, statistics*

INTRODUCTION

The source of visible and ultraviolet (UV) radiation has induced mutations to speed up generation and development the new species by its action on DNA, photosynthesis, orientation and mobility, metabolism and ultimately growth of different plants [1-2].
Non-ionizing electromagnetic radiation is characterized by small wave numbers, i.e. small wavelengths and energies which means lower quantum field, insufficient to produce ionization phenomena. In this situation the radiation exposed has penetrated only the surface sample. That category includes ultraviolet and visible light, infrared, microwaves, radio waves radiation.
Data on the effect of UV radiation on superior plants have been systematized in mainly several species of major importance in applied nature sciences. This studies are especially investigated the UV sensitive species ignored the UV-resistant plants.
It is difficult to estimate the degree of sensitivity to UV radiation exposure, even after a complex analysis. Results from the literature seem to show variations in the productivity of both quantitative and qualitative change following exposure to UV radiation. Kang *et al.* [3] show in study of HaCaT cells that UVB radiation induced cellular damage and apoptosis, with a decreased generation of reactive oxygen species (ROS) and aldehydes. Jay *et al.* [4] described that UV mechanism on the bacterial cell induced the production of lethal mutations as a result of action on DNA. Because the poor penetrative capacities of UV limits to surface applications, where it may catalyze oxidative changes that lead to rancidity, discolorations, and other reactions. Measurements of individual plants by Barnes *et al.* [5] revealed significant differential effects of the UV-B on shoot morphology like leaf length and leaf insertion height – a measure of the position of leaves in the canopy. Zuk-Golaszewska *et al.* [6] observed that enhanced UV-A decreased leaf area ratio plant biomass but increased biomass leaf area productivity. Other studies have shown that exposure to UV-B in the whole-plant are changes in morphology as the result of an inhibition in the elongation or expansion of individual organs, while in other cases plant growth is stimulated by UV-B [3-6]. The UV-light activates aromatic amino-acids (Tyr, Trp, Phe) and thiols on the outside of the protein, which leads to coupling to the slide surface as well as cross linking between proteins [7]. Under non-ionizing radiation with the wavelength between 400 and 800 nm has been developed a number of pigments like chlorophyll a (350 - 700 nm), phycoerythrin (450 - 580 nm), phycocyanin (460 - 650 nm) and bacteriochlorophyll a (750 - 850 nm) [1]. UV radiation acts positively and negatively on the plant morphology [8-9], induces mutation and takes part in the production of vitamin D.
Molecular bases of these changes occurred after irradiations are not yet fully known. Responses can be caused by direct effects of UV radiation on essential components and membranes cellular under the action of free radicals, reducing mRNA transcription and effects on protein synthesis and enzymatic activity.
The main purpose of this study was to discriminate and to find the relations between rape samples that germinated from seeds exposed to different UV-VIS irradiation times. The quality of differentiation was evaluated by comparing the results from multivariate exploratory statistical methods.

MATERIAL AND METHOD

Radiation measurements

To explain the interaction of electromagnetic radiation with the substance is required to consider that the main physical phenomenon resulting from the interaction photon flux energy and the sample is energy absorption.
Depth of penetration into the tissues of ultraviolet radiation (Figure 1) [8] and their primary effects vary depending on their wavelength: those with shorter λ penetrate to 0.5 mm (acting on substances in the core structure) and those with longer λ up to 2 mm (acts primarily on the cytoplasm), while fully absorbing.
Rape seeds samples were exposed to different doses of irradiation corresponding at 160, 280, 460 minutes respectively exhibit time. For this purpose, was used as a source of optical radiation at high pressure discharge lamp (Hg lamp).
This high pressure lamp emits UV radiation specific and visible, its main characteristics are: the emission of a continuous spectrum which is overlaps over a range of lines, the incoherent emission and continuous wave radiation. The mercury is used as an emission medium.
High pressure Hg lamp used in this work emits incoherent continuously radiation with wavelengths between 300 and 750 nm. The emitted radiation continuous spectrum is overlapping over intense emission lines at 365, 436, and 546 nm and lower intensity emission lines at 409, 577, 579, 620 and 700 nm (Figure 2) [10].

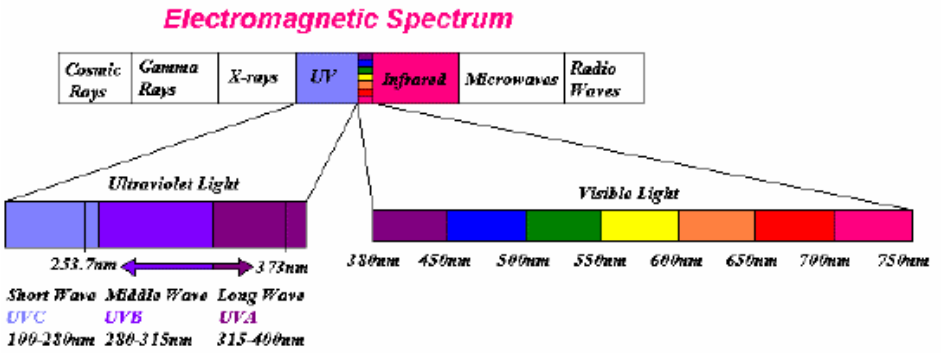

Figure 1. *Electromagnetic wave spectrum charts [8]*

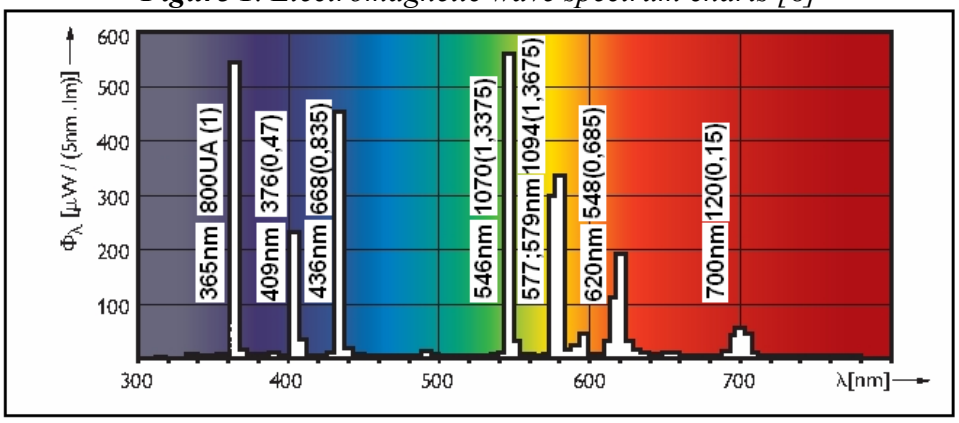

Figure 2. *Spectral radiant flux of Hg lamp [10]*

In Figure 2 the wavelengths of lines and surfaces emitted peaks in arbitrary units are specified. The irradiant ratios for various wavelengths as the 365 nm unit radiation are presented in parentheses.

Germination plant parameters

After irradiation, the rape (*Brassica napus*) seeds were wetted with distilled water using a pipette. Then, plastic trays (P control, P1, P2 and P3) were placed in room air in the dark and 22°C (Figures 3 - 5).
The next day, after placing the seed trays for germination, the germinated seeds were identified one from each sample. The seeds were moistened with distilled water using the pipette. Trays were removed from the room air and left without cover in a room with a temperature of 23 - 24°C for growth. After two days the root length and stem height were measured.

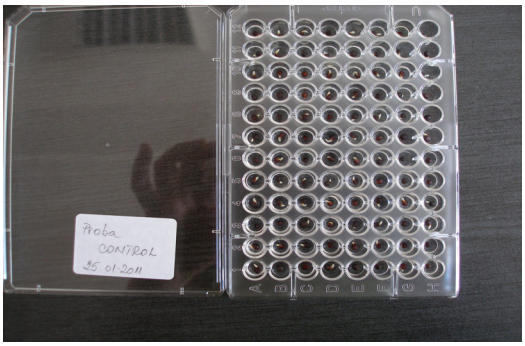

Figure 3. *Control rape seeds*

Figure 4. *All rapeseed samples*

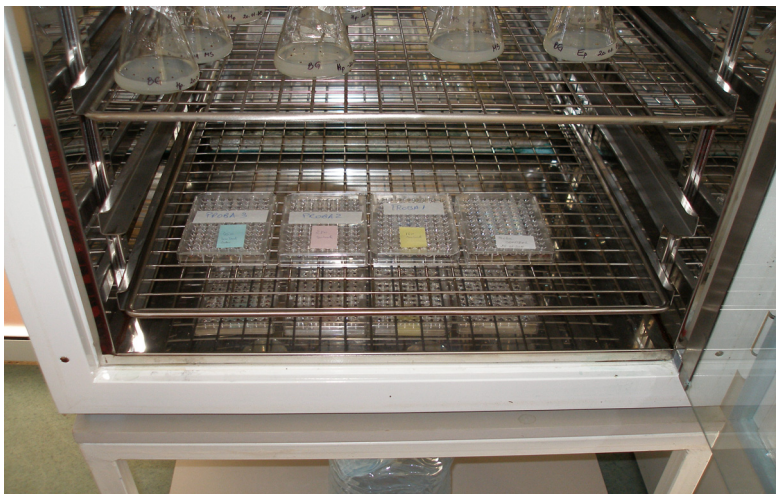

Figure 5. *Rapeseed samples in germination air room*

Statistical data analysis

All statistical analyses were performed using the SPSS software. Multivariate exploratory techniques, Descriptive Statistics Analysis and Curve Estimation Regression Analysis, were performed to compare the results of rapeseed discrimination.

Different summary measures are close to different types of data, depending on the level of measurement such as: nominal, categorical and ordinal data. For categorical data, the most typical summary measure is the number or percentage of cases in each rapeseed category. For ordinal data, the median may also be a useful to analyses our date measurement. The Descriptive Statistics Frequencies tables display both the number and percentage of cases for each observed value of rapeseed measured parts [11-14].
Analyzing the experimental data, the following groups' behavior has been established:
- plant height (stem) varies between:
  - 0.0 and 0.4 cm;
  - 0.4 and 0.8 cm;
  - 0.8 and 1.0 cm;
  - 1.0 and 1.4 cm;
- root length varies between:
  - 0.0 and 0.5 cm;
  - 0.5 and 1.0 cm;
  - 1.0 and 1.5 cm;
  - 1.5 and 2.0 cm;
  - 2.0 and 3.0 cm.

All of dimension measurements are done after two days of growth for each plant, regardless of irradiation time.

RESULTS AND DISCUSSIONS

The physiological changes of rapeseed samples which were exposed to different doses of irradiation corresponding at 160, 280, 460 minutes have been analyzed, using for this a source of optical radiation at high pressure discharge lamp (Hg lamp).
The growth and development of roots and stems samples of rape grown from irradiated seeds have been compared with those of rape samples grown from not irradiated seeds. The results are presented in Figures 6 - 13.

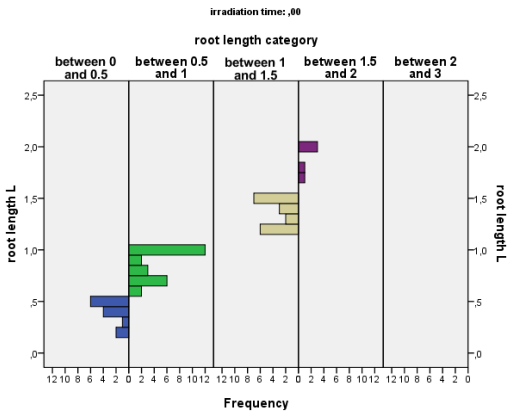

***Figure 6**. The root length (cm) of plants from not irradiated rapeseeds*

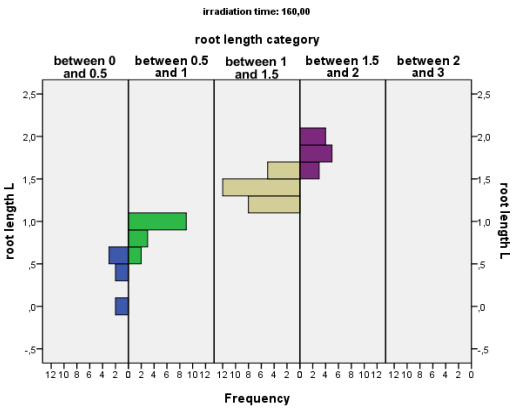

***Figure 7**. The root length (cm) of plants from rapeseeds irradiated for 160 minutes*

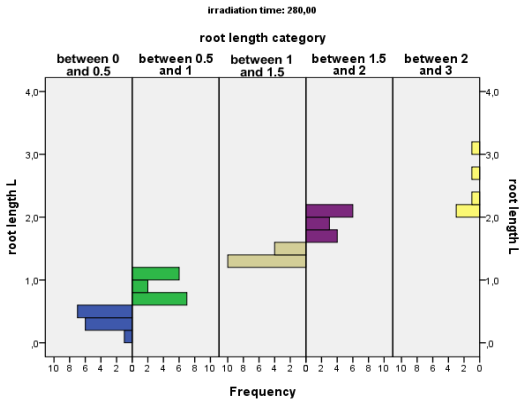

Figure 8. *The root length (cm) of plants from rapeseeds irradiated for 280 minutes*

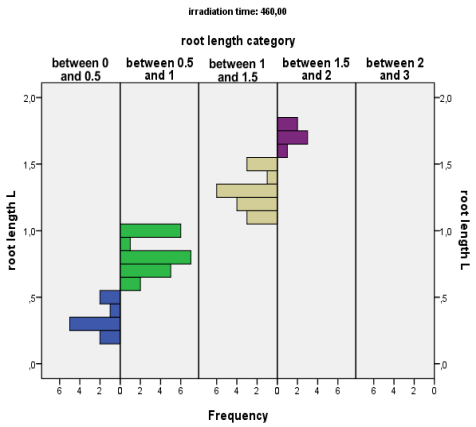

Figure 9. *The root length (cm) of plants from rapeseeds irradiated for 460 minutes*

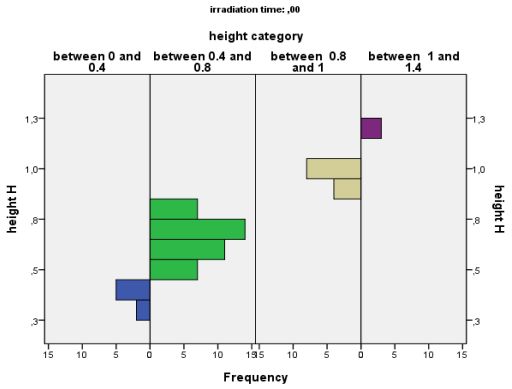

Figure 10. *The stem height (cm) of plants from not irradiated rapeseeds*

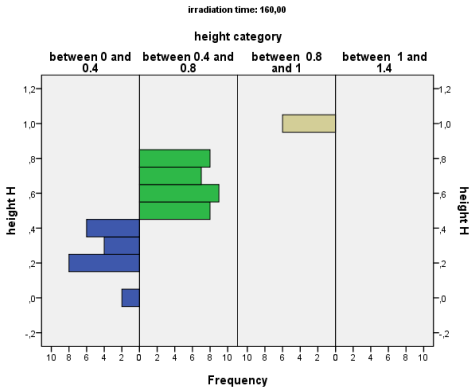

Figure 11. *The stem height (cm) of plants from rapeseeds irradiated for 160 minutes*

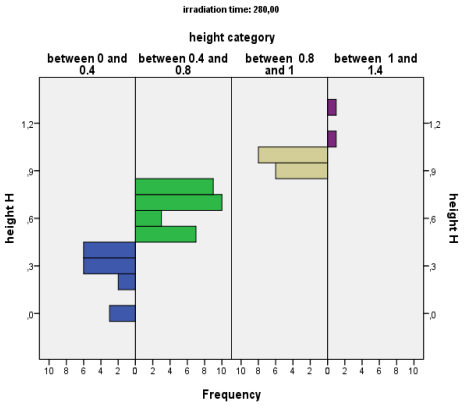

Figure 12. *The stem height (cm) of plants from rapeseeds irradiated for 280 minutes*

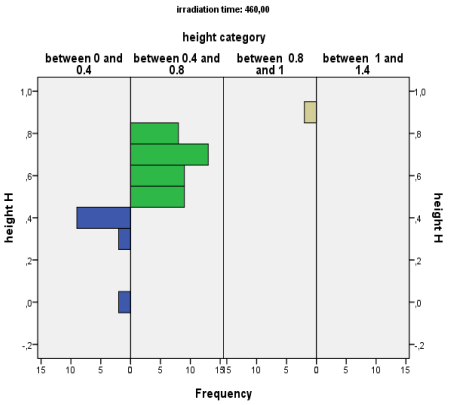

Figure 13. *The stem height (cm) of plants from rapeseeds irradiated for 460 minutes*

It has been noticed that with increasing irradiation time until 280 minute the frequency of roots length are increased (Figure 6). Most no irradiated rapeseeds (Figure 6) have root length sizes ranging between 0.5 and 1 cm. At 160 min irradiation time (Figure 7), the frequency root length category shift to higher values at 1-1.5 cm range. For 280 minutes irradiation times (Figure 8) the roots grow significantly in length, exceeding 2 cm. In 460 minutes irradiation times case (Figure 9) the growth is inhibited and the root length are no more than 2 cm high (Figure 10).
The height growth rates are highest for 280 min irradiation time for rapeseeds (Figure 12) even from no irradiated rapeseeds (Figure 10). At 480 min irradiated rapeseeds the height of rapeseeds (Figure 13) is rapidly decreasing compared to 160 min irradiated rapeseeds case (Figure 11).

CONCLUSIONS

UV radiation is absorbed by proteins and nucleic acids, in which photochemical changes are produced and cell death may be occurred.
Despite poor penetrative capacities of UV limited to surface applications, the measurements of individual height and root length of rapeseed samples exposed to non-irradiation revealed significant differential effects of the UV-A radiation.
The present studies have shown that exposure to UV-A in the whole-plant induced changes in morphology and physiology as the result of an inhibition in the elongation or expansion of individual organ. At 280 min irradiation cases the rapeseed (*Brassica Napus*) growth is stimulated by UV-A radiation.

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