

PA-05

## Changes of Shoot and Root Growth by Gamma-ray Treatments in Quinoa

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### [Introduction]

The quinoa (*Chenopodium quinoa* Willd), an annual pseudo-cereal that has been cultivated since 7000 years in the Andes Mountains. Recently, it is attracting interest in Korea as 'super grain' and is cultivated in the highlands of Gangwon-do, but the results of cultivation experiments are poor. This experiment was conducted to investigate the hormesis effect on the shoot and root growth of quinoa plants grown from seeds treated with different levels of gamma radiation through various physiological measurements.

### [Materials and Methods]

Quinoa seeds were treated with 50 Gy, 100 Gy, and 200 Gy depending on the absorbed dose at 1 kGy per hour at room temperature using the Co<sup>60</sup> Gamma Irradiation Laboratory of the Korea Atomic Energy Research Institute (KAERI). Growth measurements were conducted weekly from two weeks after transplanting (DAT). NDVI and Fv/Fm of leaves were measured by NDVI meter (Plantpen NDVI 300) and chlorophyll fluorescence meter (OS-30p). Root length, surface area, average diameter, number of tips and forks were measured using Win RHIZO.

### [Results and Discussion]

Plant height increased as the radiation intensity was increased from 50 Gy to 100 Gy until 56 DAT compared to the control, but the height was decreased at the radiation intensity of 100Gy after 63 DAT compared to the control. There was no significant differences in Fv/Fm value between treatments until 49 DAT, but increased slightly by 50 Gy treatment at 56 DAT. NDVI also showed no significant difference between radiation intensities except 200Gy treatment that shows slightly higher than other treatments until 42 DAT. As a result of the shoot responses, the positive radiation hormesis effect was shown in 50Gy and 100Gy treatment compared to the control, but the negative effect was shown in 200Gy treatment. This suggests that high doses of ionizing radiation negatively affected the proteins involved in chlorophyll biosynthesis in plants. In the first measurement of the underground part at 35 DAT, the average root diameter and root volume were the greatest as 0.432mm and 3.045cm<sup>3</sup> in control, the total length, surface area, number of tips and forks were the greatest in the plants treated with 50 Gy radiation as 2,557cm, 305cm<sup>2</sup>, 10,741 and 22,409, respectively. In the second measurement (91 DAT), the control and 50 Gy treatment tended to be similar to the previous result, but the 100 Gy treatment showed lower values than the control. This is results means that 50 Gy treatment has better ionizing radiation effect in the underground part than 100 Gy treatment during the later growth period.

### [Acknowledgement]

This study is a part of the results of the research funded by the Korea Research Foundation (Project Number: 2017R1A2B40046720173). Thanks to all those who cooperated in conducting the research project.

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