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Determination of optimum gamma ray range for radiation mutagenesis and hormesis in quinoa (*Chenopodium quinoa* Willd.)

Chan Young Park[1)], Seon Hwa Song[2)] , Jong Mu Sin[1)], Hyeon Young Lee[1)], Jin Baek Kim[3)], Sang In Shim[2)*]

[1)] *Department of Applied Biological Science, Applied Biology(BK Plus), Gyeongsang National University*
[2)] *Department of Agronomy, Gyeongsang National University, Jinju 52828, Korea*
[3)] *Korea Atomic Energy Research Institute 29 Geumgu-gil, Jeongeup-Si, Jeollabuk-do 26212, Korea*

Abstract

Quinoa (*Chenopodium quinoa* Willd.) is one of the ancient crops cultivated in the Andes region at an altitude of 3,500-4000m in Chile and Bolivia from 5000 BC. It contains a large amount of protein, minerals and vitamins in comparison with other crops. The cultivation area has been increasing worldwide because of its excellent resistance to various abiotic stress such as salinity, drought and low temperature. γ-Ray radiation of high dose is often used as a tool to induce mutations in plant breeding, but it has a deleterious effect on organisms. However, the radiation may have a positive stimulatory effect of 'hormesis' in the low dose range. This experiment was carried out to investigate the optimum dose range for creating the quinoa genetic resources and to investigate the hormesis effect at low dose on the quinoa. This experiment was performed for 120 days from November, 2016 to February, 2017 in the greenhouse of Gyeongsang National University. γ-Ray radiation was irradiated to seeds at 0 Gy, 50 Gy, 100 Gy, 200 Gy, 300 Gy, 400 Gy, 600 Gy, 800 Gy and 1000 Gy for 8 hours. (50 Gy) using the low level radiation facility (Co^{60}) of Cooperative Research Institute of Radiation Research Institute, KAERI. Fifty seeds were placed on each petri dish lined with wet filter paper and germination rate was measured at a time interval of 2 hours for 40 hrs. The length of the root length was measured one week after germination. Each treatment was carried out in 3 replicates. The growth of seedlings were investigated for 10 days after transplanting of 30 day-old seedlings. The plant height, NDVI, SPAD, Fv/Fm, and panicle weight were measured. The germination rate was highest at 50Gy and 0Gy and the rate of seeds treated with 400Gy or higher rate decreased to 25% of the seeds treated with 50Gy. The emergence rate of seedling in pot experiment was higher at the dose of 200 Gy, 300 Gy and 400 Gy than at 0 and 50Gy. However, the rate was lower at strong radiation higher than 600Gy at which 1^{st} leaf was not expanded fully and dead due to extreme overgrowth at 44 days after treatment (DAT). The highest value of panicle weight was observed at 50Gy (6.15g) and 100Gy (5.57g). On the other hand, the weight at high irradiated dose of 300Gy and 400Gy was decreased by about 55% compared to low dose (50 Gy). NDVI measurement also showed the highest value at 50 Gy as the growth progressed. SPAD was the highest at 400 Gy and showed positive correlation with irradiation dose except 0 Gy. Fv/Fm was high at 50 Gy up to 30 DAT and no difference between treatments was observed except for 400 Gy from 44 DAT. The plant height was the highest in 50Gy during the growing period and was higher in the order of 50Dy, 100Gy, 0Gy, 200Gy, 300Gy and 400Gy in 88 DAT. In this experiment, the optimal radiation dose for hormesis was 50Gy and 100Gy, and the optimal radiation dose for mutagenesis seems to be 400 Gy.

Keywords: Quinoa, Hormesis, γ-Ray Radiation, Mutagenesis

Corresponding author*
Sang In Shim
Address Department of Agronomy, Gyeongsang National University, Jinju 660-710, Korea
Tel and Fax 055-772-1873
E-mail sishim@gnu.ac.kr