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Effect of Gamma Irradiation and Salt Stress on Survival Rate and Growth of Hom Thong Banana

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Banana is a tropical fruit used as staple food for low-income populations. However, the productivity is still low as it is grown in salinity area. Strategy undertaken to solve this problem is improvement of new variety through mutagen. In this study, *In vitro* shoots were exposed to gamma rays at doses of 0, 10, 20, 30, 40, and 50 Gy and regenerated on medium containing salt concentration of 0, 6, 8, 10 g/L NaCl. The result showed that severity of salinity was reduced by gamma irradiation. The survival rate of irradiated shoots cultured on 8 g/L NaCl was higher than non-irradiated shoots. Result was indicative that gamma irradiation can be considered an alternative method to increase salt tolerance of commercial variety.

Keywords: Gamma Irradiation, Salt stress, Hom Thong banana

Introduction

Banana is a tropical fruit, propagated from new sucker or tissue culture. It is grown in all Thailand from the coastal plain to the highland. In 2012, the area planted with banana was approximately 76,073 ha, giving an estimated production of 1,031,118 t year^{-1}. The climatic conditions of Thailand are suitable to development and production of banana. However, productivity is still low as there are several problems. One of the main problems is salinity.

Salinity affects plant metabolism processes such as osmotic inhibition of water availability (Hartz, 1984) or modification of protein profiles (Beltagi *et al*., 2006). Fenn *et al*., (1968) showed that accumulation of chloride was more toxic than sulphate in the mechanism of plant injury. Chloride and sodium ion were the dominant factors in reducing fruit crops growth (Leon, 1980). In banana, salinity affected both vegetative and chemical properties (Gomes *et al*., 2001). So, it is important to improve salinity resistance in banana. However, the genetic improvement of bananas is hampered because of several reasons such as inherent polyploidy, parthenocarpic fruit development, low levels of female

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fertility and raising asexual progeny in sufficient numbers to recombine desirable characters. In addition, it is further complicated by low seed germination of hybrid plants (Javed *et al*., 2004). Induced mutation by gamma irradiation has been applied to as a tool to generate variation especially banana (Hautea *et al*., 2004).

Gamma irradiation is an effective technique for breeder. Gamma rays belong to ionizing radiation which interacts to atom or molecules inside irradiated cells and produces free radicals. Free radicals have been reported to affect changes in cellular structure and metabolism, e.g. dilation of thylakoid membranes, alteration in photosynthesis, modulation of antioxidative system and accumulation of phenolic compounds.

The objectives of the present study were to investigate the induction of genetic variability using gamma radiation and study the morphological changes of banana that would differentiate salinity resistance from gamma irradiation.

Meterials and methods

Plant material and culture conditions

The commercial Hom Thong banana variety was used as the experimental material. The sucker of mature plant was harvested from field-grown plants at Valaya Alongkorn Rajabhat University under the Royal Patronage, Sakaeo campus, Sakaeo, Thailand. After removal of the outer leaves, the innermost suckers were cut into 3-5 cm pieces and washed first in tap water and then for 5 min in sterile distilled water for 3 times. Surface decontamination was performed with 95% ethanol (v/v) for 5 min and mercury chloride (0.1% w/v) for 5 min, followed by three washes with sterile distilled water for 15 min each. Suckers were aseptically inoculated onto MS (Murashige and Skoog, 1962) medium supplemented with 2 mg/L BA and 3% sucrose. The pH of culture medium was adjusted to 5.8 before autoclaving. This medium is referred to as sucker induction medium. Cultures were incubated inside sterile room at 25±2 ℃ at relative humidity 70-80% under photoperiod of 16 h for 4-5 weeks until 1 cm-height suckers appeared.

Gamma irradiation and treatment with NaCl concentration

Gamma irradiation was carried out with a Cs^{137} source. Suckers were irradiated with different doses of gamma rays (6 level; 0, 10, 20, 30, 40, and 50 Gy). For the selection of salt tolerance, irradiated-suckers were transferred onto

MS medium supplemented with 0, 6, 8, 10 g/L NaCl. The survival rate and growth were recorded at the vegetative stage after 50 days of culture.

Statistical analysis

The experimental design was completely randomized design (CRD). The analysis of variance (ANOVA) was used to determine the differences in average of all parameters between irradiated and non-irradiated suckers. Three replications with 10 samples per each replication were applied.

Results

The effect of salinity was studied on banana. Survival rate of banana suckers growing on induction medium supplemented with different amounts of NaCl was determined after 2 months. All non-irradiated sucker cultured on medium without salt fully regenerated when subcultured on fresh medium (Table 1). Salinity caused drastic effect on survival rate. More than 50% of banana failed to regenerate when subcultured on highest level of salt (10 mg/L). Gamma irradiation reduced effect of salt on banana cultured on medium added with 8 mg/L.

Table 1. Effect of gamma irradiation and salinity concentration on Hom Thong banana survival rate

NaCl	Radiation dose/Gy.					
conc/g/L	0	10	20	30	40	50
0	100	100	100	90	90	70
6	75	75	75	65	60	55
8	45	70	70	55	45	45
10	45	40	40	35	25	25

Sensitivity of Hom Thong banana towards irradiation and salt was further demonstrated. The irradiation dose and salt had and negative impact on plant height as shown in Table 2 and Fig.1 and 2. The average plant height decreased with increasing gamma radiation dose.

Discussion

The results showed by the radiation sensitivity test, based on survival rate, showed reduction in survival percentage as observed with increasing gamma dosage. These results were in accordance with radiation sensitivity test done by Hasegawa *et al*., (1995), for tobacco, El-Fiki (1997) for potato, El-Fiki *et al*.,

(2005) for alfalfa, Norfadzrin *et al*., (2007) for tomato and Kiong *et al*., (2008) for *Orthosiphon stamineus*.

Table 2. Effect of gamma irradiation and salinity concentration on Hom Thong banana growth

NaCl	Radiation dose/Gy.					
conc/g/L	0	10	20	30	40	50
0	1.68±0.29a	1.23±0.23a	0.71±0.17a	0.83±0.23a	0.63±0.16a	0.55±0.09a
6	0.61±0.12b	0.41±0.06b	0.40±0.09b	0.38±0.04b	0.36±0.05b	0.39±0.11b
8	0.40±0.07c	0.39±0.07b	0.37±0.02c	0.36±0.02b	0.36±0.04b	0.36±0.04c
10	0.38±0.02c	0.36±0.04b	0.36±0.07c	0.36±0.03b	0.35±0.06b	0.33±0.03d
C.V.(%)	0.28	0.17	0.03	0.06	0.02	0.01

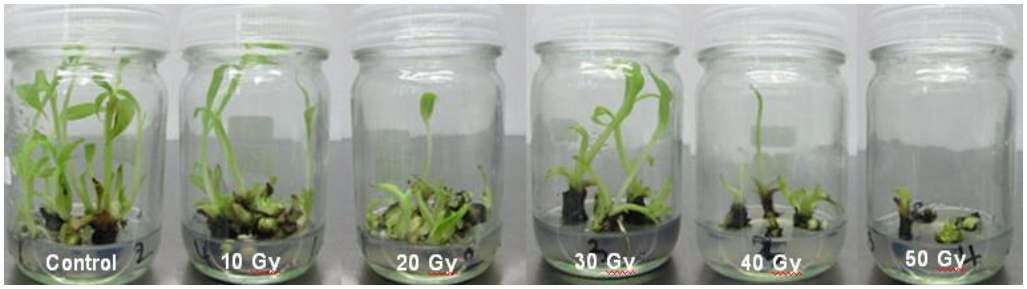

Figure 1. Effect of gamma radiation dose on Hom Thong banana survival rate and growth

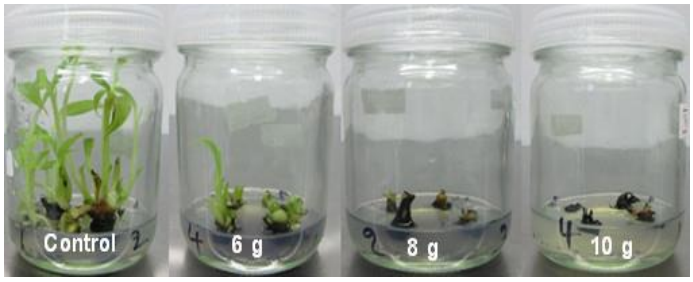

Figure 2. Effect of NaCl concentration on Hom Thong banana survival rate and growth

Screening of mutagenized cultures during dedifferentiation and differentiation stages could be useful for salt tolerance selection. The present study indicated increasing in survival rate of banana exposed to gamma irradiation and cultured on medium supplemented with salt. This increasing may have resulted from changes defensive mechanisms. Gamma irradiation modulated expression in the metabolic and synthesis of osmolytes which have been correlated with their capacity to tolerate and adapt to salinity condition.

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