RES. BULL. PL. PROT. JAPAN No. 28 : 27~31 (1992)

Short Communication

Electron Beam Irradiation to Control Pests on Carnation Cut Flowers —— Effects of Irradiation on the Quality of Plants

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Abstract : Four cultivars of carnation cut flowers were irradiated three days after harvest with the electron beam from Cockcroft-Walton's accelerator, where absorbed doses were 0.13, 0.42, 1.18 and 4.10 kGy. After irradiation plants were stored for 15~25 days at 2, 10 and 25°C. The responses of cut flowers to the irradiation differed with cultivars. At doses of 1.18 kGy and less, Sandorosa® and Corso® cultivars were not inferior in quality as compared with non-irradiated control and their vaselife was extended by irradiation at higher dose. After the 4.10 kGy irradiation a pink flower of Sandorosa® slightly discolored. A dose-response relationship in Pallas® and White Candy® was not clear. Damages on flowers were influenced by the storage conditions rather than irradiation conditions. The higher temperature during storage caused the earlier and severer chlorosis and wilting of plants.

Key words : *Dianthus caryophyllus*, commodity treatment, vaselife, electron accelerator, discoloration, chlorosis

Introduction

The increasing demand for cut flowers is augmenting their import. The number of cut flowers imported in 1989 was 360 millions, which is 1.2 times of that in 1988. The increased import will increase concurrently the potential danger by mites, thrips an other insect pests to the domestic agriculture. On the other hand, the current fumigation schedules are time-consuming because of not only the treatment time but controlling temperature to fumigate commodities transported at low temperature (WIT and VRIE, 1985a). Since the import of carnations, which are infested with insect pests with high frequency, tends to concentrate in a month before Mather's Day in May, the development of an alternative treatment method which is more quick and effective is required.

The irradiation is a possible method to disinfest various pests infesting cut flowers, since it can control infesting pests in a short time without damaging plants in carton boxes (KÖLLNER, 1977 ; WIT, 1986 ; WIT and VRIE, 1985b). Although gamma irradiation has been researched and used to process agricultural products, electron beam has been mainly applied in curing coatings, plastic films and rubber materials becuase of its lesser penetrative ability. Recently the limited supplies of gamma ray sources is stimulating the development of new electron accelerators with higher penetration that can provide an alternative to gamma ray sources for processing bulk materials and agricultural products (CLELAND and PAGEAU, 1985).

In the present study electron beam irradiation was attempted to obtain fundamental information of effects of irradiation and storage temperatures on quality of the carnation cut flowers.

Materials and methods

Cut flowers used were cultivars of a standard type carnation grown in green houses in Chiba prefecture and cut into 90 cm in length. Plants were harvested and stored in carton box at room temperature for three days before irradiation.

The irradiation was performed with Dynamitron® accelerator at Electron Beam Service and Application Research Center, Sumitomo Heavy Industries, Ltd. The accelerator is a kind of Cockroft-Walton's apparatus and operated at 5 MeV of the maximum energy and 40 mA of the maximum beam current. An absorbed dose was regulated by controlling the electric current and the voltage and measured with GAF chromic dosimeter (model D-200, Nordion International Inc. Canada). The doses examined were 0.13 ± 0.01 kGy, 0.42 ± 0.01 kGy, 1.18 ± 0.08 kGy and 4.10 ± 0.08 kGy and dose rate was 0.05 kGy/sec, 0. 18 kGy/sec, 0.51 kGy/sec and 2.97 kGy/sec, respectively. Plants were laid without overlapping each other on a corrugated cardboard (40 mm in thickness) on a cart which automatically conveys commodities through the irradiation room at the speed of 20 m/min, where the distance between the scan horn of the accelerator and plants was 935 mm and 380 mm at 0.13~1.18 kGy and 4.10 kGy, respectively. Since ions are formed in medium through which high energy electrons pass, the irradiation room was ventilated to eliminate ozone generated in the atmosphere during irradiation.

After irradiation, cut flowers were dipped in water without preservatives and stored for 15 to 25 days at 2°C, 10°C and 25°C, and at 92% R.H., 90% R.H. and 62% R.H., respectively.

Results and discussion

The carnation is a tolerant plant to irradiation at a dose sterilizing insect pests (KÖLLNER, 1977 ; WIT and VRIE, 1985b). In the present study, no injuries were obserbed immadiately after irradiation. In the case of pink-flowered Sandorosa® cultivar, however, visible discoloration of whole flower was found at the dose of 4.1 kGy immediately after irradiation. Active oxgen compounds formed in the plant tissues and the atmosphere during irradiation seem a possible factor causing the lighter flower color. Irradiation under an anaerobic condition will clear the action of active oxgen.

Chlorosis and wilting on leaves and/or stems became visible over ten days after irradiation, dipending on dose and storage temperature.

Scorching of leaves, which was reported for *Chrysanthemum* cut flowers and other plants (WIT and VRIE ; 1985b), was not found in the four cultivars tested.

A shorter vaselife, which seems to be caused by irradiation, was noted in Sandorosa® and Corso® cultivars irradiated at 4.1 kGy and stored at 2°C and 92% R.H. (Fig. 1), while at 1.18 kGy (Fig. 2) and less (data not shown) the vaselife was obviously extended. On the contrary, White Candy® irradiated at 4.1 kGy showed extension of the vaselife, possibly

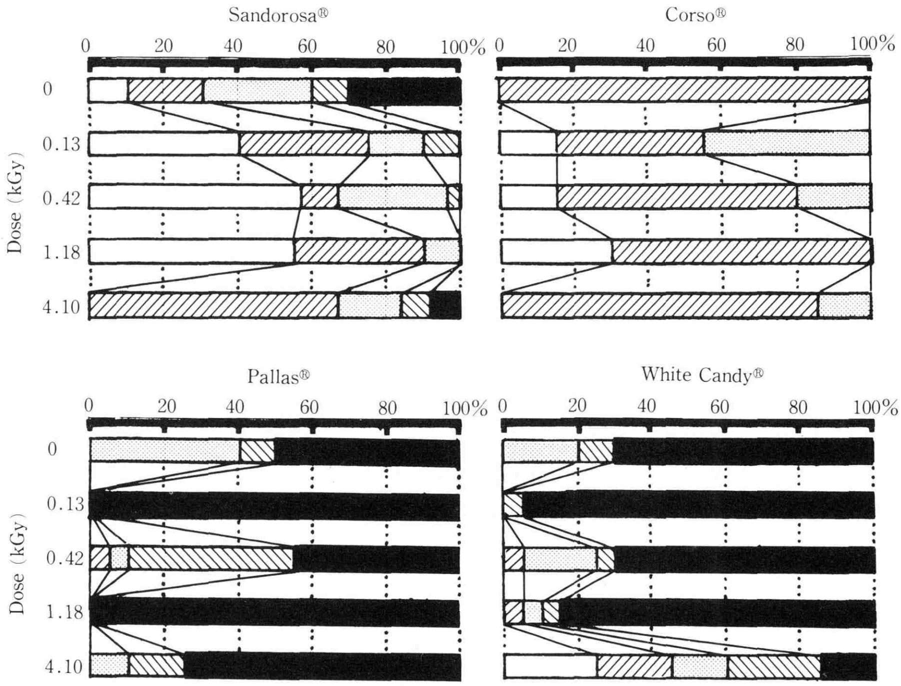

Fig. 1. Effects of electron beam irradiation on quality of four cultivars stored at 2℃ and 92% R.H. for 15 days after irradiation.

□, no damage
▨, slight browning or discoloration of flower, but no damage on leaves and stems
▒, browning or shriveled flower
▧, severe browning and shriveled flower
■, withered flower or severe chlorosis and/or wilting of leaves and stems

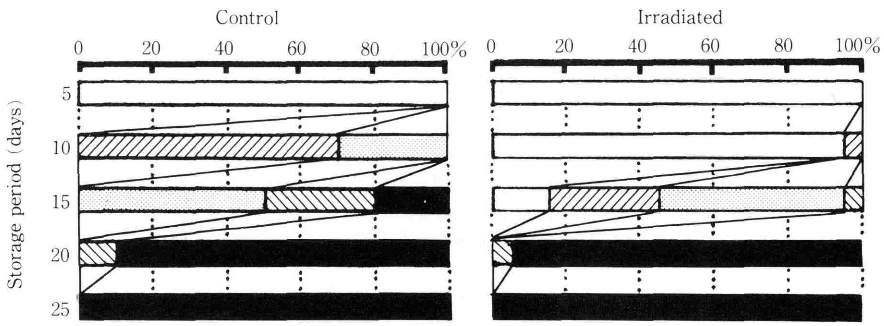

Fig. 2. Extension of vaselife in Sandrosa® cultivar irradiated at 1.18 kGy
Plants were stored at 10℃ and 90% R.H. after irradiation. Symbols are the same as Fig. 1.

due to the disinfection action of electron beam irradiation.

Carnation cut flowers are known to be affected remarkably by ethylene produced by themselves during storage (MAYAK, *et al.*, 1977 ; MAYAK and HALEVV, 1980 ; NICHOLS, 1966 ; WANG and WOODSON, 1989). The extended vaselife of Sandorosa® and Corso® was found at the dose of 1.18 kGy and less. Thus it may be due to the inhibition of ethylene production of cut flowers by irradiation. It is interesting to investigate effect of electron beam irradiation on ethylene production and related senescence of plants. Also application of preservatives to control ethylene production and occurence of microorganisms should be recognized (CHIU, 1986 ; MAYAK and DILLEY, 1976 ; VEEN, 1979 ; VEEN, 1983).

Various stresses cause plants to produce ethylene, which was named 'stress ethylene' by ABELES (1973). In the present study, since mechanical shocks and desiccation during packing and transfer of flowers seemed not negligible, minor effects of the irradiation at lower doses may be masked by the action of the stress ethylene.

Therefore, further study, in which handling of plants should be improved, will give an adequate dose to disinfest carnation cut flowers without damage on plants.

Acknowledgments

The authers thank the staffs of Electron Beam Service and Application Research Center, Sumitomo Heavy Industries Ltd. for their cooperation in the irradiation of plants and Toshiyuki AKAGAWA, Mieko NAKAMURA, Takashi MISUMI and Mitsuru KATAYAMA, Research Division, Yokohama Plant Protection Station, for their technical assistance. We are also gratefull to Dr. Yusuke ICHIMASA and Dr. Michiko ICHIMASA for critical readings of the manuscript.

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