A.5: Electron Beam Irradiation using Accelerators at RRCAT

Electron beam (EB) irradiation is a valuable technique for a variety of agricultural and industrial applications. DC as well as RF linear accelerators are being used for different EB irradiation applications at IMA Section, PSIAD, RRCAT.

EB irradiation of groundnut and soybean seeds for mutation purpose was done using two different accelerators namely DC accelerator (continuous) and linear accelerator (pulsed).

Electron beam has been used as an additional mutagen in groundnut in order to create new genetic variability at Nuclear Agriculture and Biotechnology Division (NABD), BARC, Mumbai. NABD used electron beam for irradiation of fresh groundnut seeds on five varieties of groundnut seeds (TAG 24, TG 26, TG 51, TG 69 and TG 68).

Before conducting the irradiation, dosimetric measurements were carried out to optimize the operating parameters of the accelerators for delivering desirable dose to the samples. Radiochromic film dosimeters were used and procedure as recommended in the ISO/ASTM 51275 was followed for the measurements. The film is colourless before irradiation and it turns progressively blue upon exposure to ionizing radiation. The colour intensity of the film is proportional to the absorbed dose. The absorbance (change in coloration) is measured by photometric technique using Genesys 20 spectrophotometer at the recommended wavelength of 550 nm. Dose response calibration curve of the film was established by exposing the films in the dose range of 50-1000 Gy at Co^{60} gamma chamber at Radiation Standards Section, RSSD, BARC (see Fig. A.5.1). Uniform radiation field of width 50 cm, in 750 keV DC accelerator was achieved by scanning the electron beam in transverse direction with respect to the conveyor movement. Parameters of the accelerator were optimised to deliver 70 Gy/pass and higher doses were delivered by increasing the number of passes.

To deliver low doses (50-600 Gy) by pulsed electron beam, the accelerator was operated at a pulse repetition rate of 1 Hz and a scatterer was placed in the beam path to obtain wide radiation field. Trace of radiation field at 85 cm from the window foil of the accelerator with optimized scatter in place is shown in Fig. A.5.2. Field width for 10% uniformity is found to be 13 cm as shown in Fig. A.5.3. Accelerator output (for optimised parameters) was calibrated in terms of dose rate (Gray/second) and different doses were delivered by varying the exposure time.

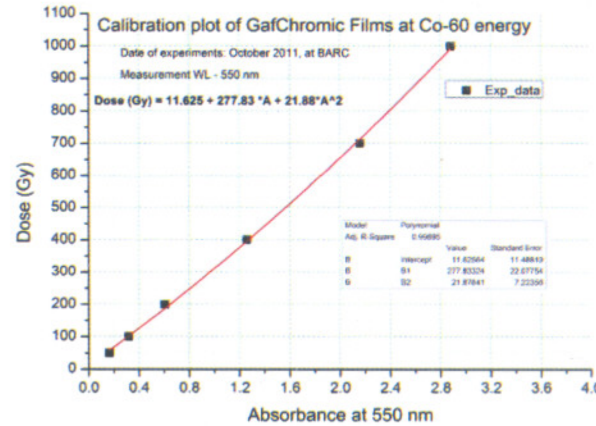

Fig. A.5.1: Dose response calibration curve of the radiochromic film

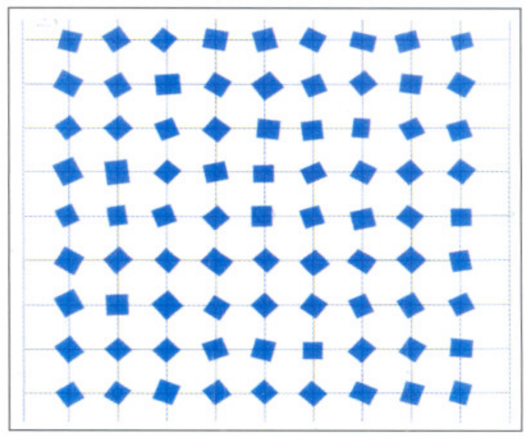

Fig. A.5.2: Trace of radiation field achieved using scatterer on sample surface

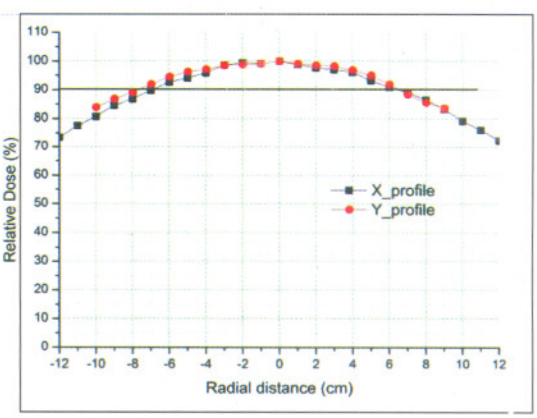

Fig. A.5.3: Dose Profile in horizontal and vertical direction

The seeds to be irradiated were positioned so that their embryos face electron beam and the seeds were made to pass through the electron beam as shown in Fig. A.5.4. Doses in the range of 75 to 750 Gy were delivered at beam energy of 700 keV from DC accelerator.

While using the linear accelerator, the seeds were irradiated at beam energy of 8.5 MeV in the dose range of 50 to 600 Gy as shown in the Fig. A.5.5.

Dosimetry was done using radio-chromic films for each batch.

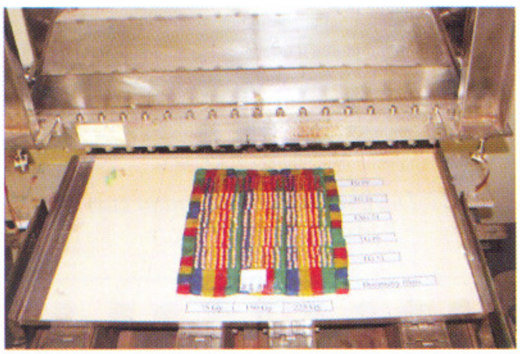

Fig. A.5.4: Groundnut seeds during irradiation with DC accelerator.

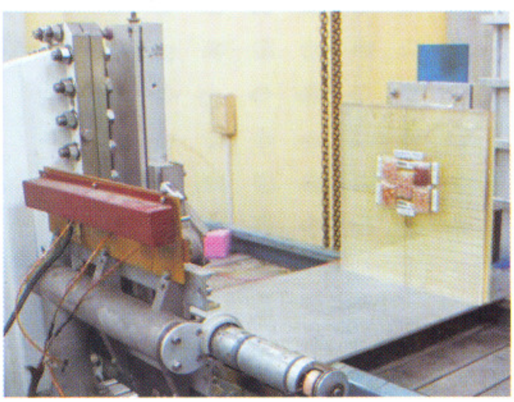

Fig. A.5.5: Groundnut seeds during irradiation with linear accelerator.

Fig. A.5.6: Irradiated groundnut seed samples.

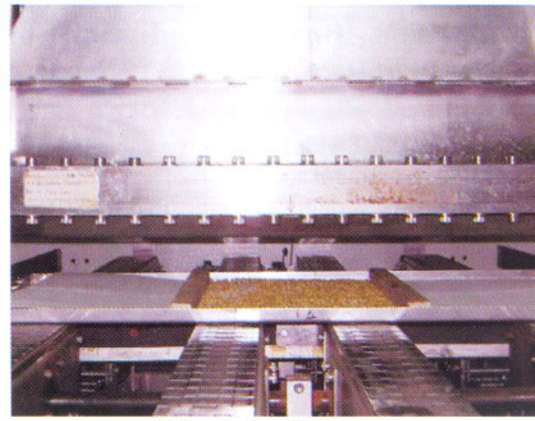

Fig. A.5.7: Soybean seed during irradiation with DC accelerator.

It was found that a linear relationship exists between plant growth reduction vs. absorbed dose in case of the dose delivered by linear accelerator. Though no such linear relationship between growth reduction vs. absorbed dose was observed in case of dose delivered by DC accelerator (due to low penetration depth of 700 keV beam which was used), but plant growth reduction in the higher absorbed dose was established. With this experience further experimental work on irradiation of groundnut seeds for mutation breeding is planned on linac.

In a separate experiment, National Research Centre for Soybean, Indore irradiated two varieties of soybean seeds (Hardee and JS97-52) as shown in Fig. A.5.7. Doses in the range of 75 to 225 Gy were delivered to both the varieties at beam energy of 700 keV from DC accelerator to study mutations in growth phases of soybean.

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