RADIOSENSITIVITY STUDIES IN PEARL MILLET (*Pennisetum glaucum*), COW PEA (*Vigna unguiculata*) AND SORGHUM (*Sorghum bicolor*) VARIETIES IN NAMIBIA

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ABSTRACT

In this experiment, three locally released cow pea varieties [Nakare (IT 81D-985), Shindimba (IT89KD-245-1) and Bira (IT87D-453-2)]; two pearl millet varieties [Okashana2 (SDMV 93032) and Kangara (SDMV 92040)]; and two *Sorghum bicolor* local farmer's varieties [Macia (SDS 3220) and red sorghum] obtained from the Namibia Botanical Research Institute (NBRI) were exposed to different doses (0, 100, 150, 200, 300, 400, 500 and 600) of gamma radiation (Gy) to determine the lethal doses (LD). The experiment took place at the FAO/IAEA Plant Breeding Unit's Agriculture and Biotechnology Laboratory A-2444, Seibersdorf in Austria. The irradiated seeds where planted under a controlled environment in a glass house where monitoring was done every day. Data was recorded and entered into Microsoft Excel to calculate the percentage growth rates and estimate the lethal doses on the curve. Results obtained revealed that the Nakare and Shindimba varieties did not survive the radiation dozes at 300 Gy, 400 Gy and 500 Gy. The same radiation strength showed no definite significant effect on the Bira variety in response to increased gamma radiation doses. Furthermore, increased gamma radiation doses of up to 600 Gy seemed not to have much of a negative effect on the germination of the Bira variety. It was therefore estimated that the optimum dose for Nakare and Shindimba is between 150 Gy and 200 Gy while for Bira it can be increased beyond 500 Gy. Pearl millet Okashana2 variety responded to gamma rays with a decreasing percentage survival rate when the gamma ray doses were increased. The LD50 of 599,12 Gy dosages and LD30 at 346,27 Gy seem to be the maximum for the pearl millet and thus the ideal doses for Okashana2 were estimated to be between 300 Gy and 350 Gy while for Kangara between 400 Gy and 500 Gy. Macia and red sorghum responded differently to gamma rays with the LD50 at 523,47 Gy and LD30 at 319,39 Gy. The optimum dose for Marcia was estimated between 300 Gy and 350 Gy. Red sorghum showed the LD50 at 974,8 Gy and LD30 at 574,80 Gy. However, the estimated optimum dose here was between 500 Gy and 600 Gy.

INTRODUCTION

Mutation techniques have been used for generating genetic variation and breeding new varieties during the past decades. Gamma irradiation (Gy) is the main physical mutagen used to induce genetic variation. Genetic variation is the starting point of any breeding programme. Genetic variation may already be present in nature, may be obtained after several years of selection, or may be produced through hybridization (for seed propagated crops). Mutagenic agents such as radiation and certain chemicals can be used to induce mutations at a higher frequency and generate genetic variation from which desired mutants may be selected. In this experiment, three cow pea varieties, two pearl millet varieties and sorghum obtained from the NBRI were exposed to different doses of gamma radiation to determine the lethal doses.

MATERIAL AND METHODS

Dry seeds from three important and released cow pea varieties (Nakare, Shindimba and Bira), two pearl millet varieties (Okashana2 and Kangara) and two *Sorghum bicolor* varieties (Macia and red sorghum) from Namibia were irradiated with gamma rays. Ten seeds were sown per variety on filter paper in Petri dishes by using distilled water and germination was recorded after seven days to determine the germination percentage and seed viability. After the germination test, 30 seeds per variety were packed in seed envelopes and placed in decicators for three days to attain the same moisture content. Six different doses (0, 100, 150, 200, 300, 400, 500 and 600 Gy) were applied respectively in a complete randomized experiment replicated three times prior to planting in seed trays in the greenhouse controlled environment with 22 °C to 35 °C, light of 12 hours photoperiod (Figure 1). Seedlings were watered twice a week to ensure the soil in the seed trays was moist and not over-watered.

Seedling height at 14 days was recorded for both epicotyls and hypocotyls as parameters. Seedling height of the control (0 Gy) was used as the index of the normal growth of each variety or inbred line whereby the mean seedling height was expressed as a ratio to the corresponding control value. Seedling height is widely used as an index in determining the biological effects of various physical and chemical mutagens as described by Ali Cheema and Atta (2002).

RESULTS

The average differences in seedling plant heights for pearl millet varieties and hypocotyl and epicotyl length for cow pea, between the untreated and irradiated materials were

expressed as percentages of the heights of the untreated control samples (Tables 1 to 4). These percentages were plotted against the gamma irradiation doses to determine the optimum dose (Figure 2).

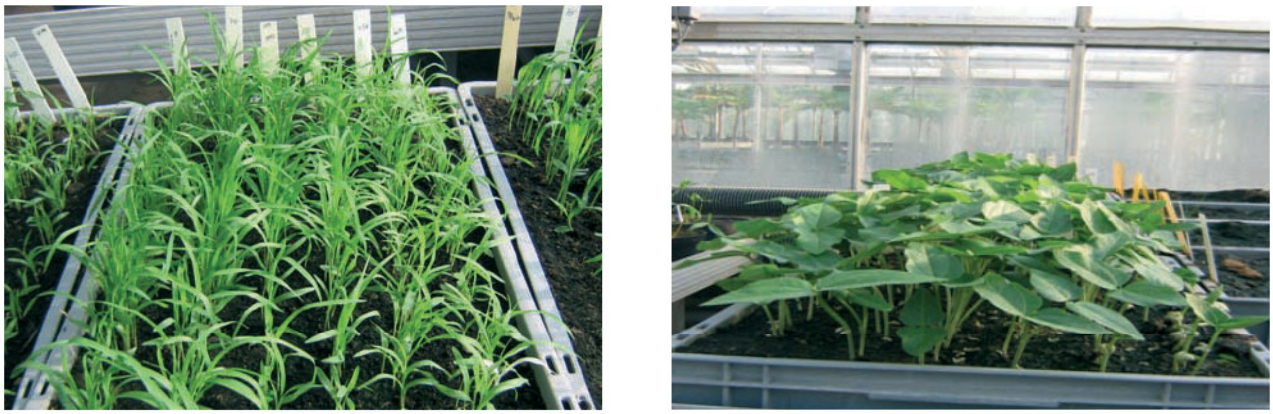

Figure 1. The irradiated pearl millet, Okashana2, (left) and cow pea, Bira, (right) varieties evaluated in greenhouse conditions.

Cow pea

Table 1. Survival (as a percentage of the control) of the epicotyls of the three (*Vigna unguiculata*) varieties grown in the greenhouse two weeks after irradiation with different doses of gamma rays

Variety	Dose (Gy)							
	0	100	200	300	400	500	LD50	LD30
Nakare	100	102,49	63,38	0	0	0	227,82	147,18
Shindimba	100	90,84	81,52	50,52	0	0	636	417,05
Bira	100	103,07	96,43	77,81	66,12	63,74	267,25	179,90

Table 2. Survival (as a percentage of the control) of the hypocotyls of the three cow pea varieties (*Vigna unguiculata*) grown in the greenhouse after two weeks of irradiation with different doses of gamma rays

Variety	Dose (Gy)							
	0	100	200	300	400	500	LD50	LD30
Nakare	100	95,02	28,33	0	0	0	195,04	103,98
Shindimba	100	89,88	76,44	15,29	0	0	515,39	332,39
Bira	100	108,87	87,57	62,18	57,60	59,04	519,27	335,78

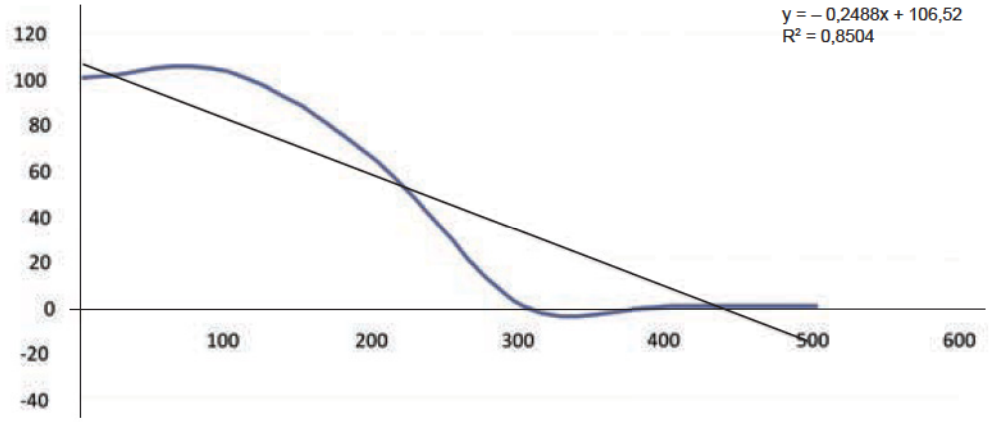

Figure 2. Percentage of reduction in plant height of seedlings exposed to gamma irradiation (compared with seedlings from untreated seeds) of Shindimba after 14 days, plotted against the gamma irradiation dosage.

Pearl millet

Table 3. Survival (as a percentage of the control) of the two pearl millet (*Pennicetum glaucum*) varieties grown in the greenhouse after two weeks of irradiation with different doses of gamma rays

Variety	Dose (Gy)							
	0	75	150	300	450	600	LD50	LD30
Okashana2	100	87,35	81,66	81,43	61,86	47,00	599,12	346,27
Kangara	100	90,84	81,52	50,52	0	0	731,49	432,99

Sorghum

Table 4. Survival (as a percentage of the control) of the two *Sorghum bicolor* varieties grown in the greenhouse after two weeks of irradiation with different doses of gamma rays

Variety	Dose (Gy)							
	0	75	150	300	450	600	LD50	LD30
Macia	100	83,95	95,61	87,40	39,00	46,95	523,47	319,39
Red sorghum	100	87,95	93,83	90,08	75,25	66,45	974,8	574,80

DISCUSSION AND CONCLUSION

An induced mutation radiation test has strong effects on both the germination and growing patterns of cow pea, pearl millet and sorghum varieties investigated in this experiment. The germination percentage decreased after gamma irradiation in all the varieties in relation to doses applied. As the irradiation doses increased beyond 500 Gy, cow pea growth decreases proportional to the increase in dosage on the two varieties, Nakare and Shindimba. This could be attributed to the texture of seed and colour since the two varieties Nakare and Shindimba are white in colour and have a soft rough seed coat. On the other hand Bira is red in colour and smooth but hard. However the size of the seed is half of that of the Nakare and Shindimba.

Bira was not physically affected by any of the gamma rays and no clear signs of radiation could be visualised unless the effect occurred at gene level and this would only be observed once the plant had grown fully. Furthermore, a zero percentage germination rate was recorded for Nakare and Shindimba at 300 Gy, 400 Gy and 500 Gy. However no definite significant effect was found on the Bira variety in response to increased Gy doses (Tables 2 and 3). Increased gamma rays doses of up to 600 Gy seemed not to have much effect on the germination of the Bira variety. The LD50 and LD30 for Nakare were estimated at 195,04 Gy and 103,98 Gy respectively for the hypocotyls, while that of the epicotyls was estimated at 227,82 Gy and 147,18 Gy respectively.

It was therefore estimated that the optimum dose for Nakare and Shindimbalies between 150 Gy and 200 Gy while for the Bira it can be increased beyond 500 Gy. The Induced mutation radiation on pearl millet varieties did not have much influence on the germination of the Okashana2 and Kangara variety. However Okashana2 variety responded to gamma rays with a decreasing percentage survival rate after germination when the gamma rays doses were increased (Table 4). The estimated lethal dose at 50 % (LD50) was 599,12 Gy and the lethal dose at 30 % (LD30) was 346,27 Gy for Okashana2. Thus the ideal dose for Okashana is estimated to be between 300 Gy and 350 Gy while for Kangara it is between 400 Gy and 500 Gy. According to Gottschalk and Wolff (1983), mutant pearl millet can be observed as culm length is often combined with an improved straw stiffness resulting in an increased lodging resistance. The two sorghum varieties Macia and red sorghum responded differently to gamma rays with the LD50 at 523,47 Gy and LD30 at 319,39 Gy.

However the optimum dose is estimated between 300 Gy and 350 Gy. Red sorghum showed the LD50 at 974,8 Gy and LD30 at 574,80 Gy. The estimated optimum dose is between 500 Gy and 600 Gy. The results presented here were from the project initiation, with the guidelines provided from the results above. This project is continuing in order to get the mutant generations. Three experiments have been set up at Mannheim Research Station. The experiments are investigating the survival rate of pearl millet; cow pea and sorghum varieties in a natural environmental condition in Namibia and mutant lines will be selected.

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