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STUDIES ON CHRONIC AND ACUTE IRRADIATION EFFECTS ON GERMINATION AND GROWTH OF SUDAN GRASS (*SORGHUM BICOLOR* (L.) MOENCH.)

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Dry seeds of Sudan grass (*Sorghum bicolor* (L.) Moench.) were subjected to chronic and acute irradiation treatments ranging from 10 to 100 kR. The sources of irradiation were 850 curies 60Co gamma beam for chronic irradiation and 4000 curies 60Co gamma cell for acute irradiation, Seedling germinability in the laboratory was not generally affected by the irradiation treatments. However, seedling heigher decreased measurably with increasing treatments of irradiation and the seedlings exposed to treatments beyond 70 kR did not survive. This suggests that such levels of irradiation are lethal to plant growth. Treatments of 10 kR to 70 kR did not have any noticeable depressing effect on tillering when compared to unirradiated seeds. Differences in dry matter contents due to variation in irradiation were not significant with the exception of 10 and 30 kR treatments which gave substantially higher dry matter contents.

INTRODUCTION

Shortage in the supply of green fodder almost throughout the year but esyecially during the summer months is one of the major problems for livestock qwners in Pakistan. Egyptian clover is most commonly used to supply green sunmer during winter months but there remains need for such species that can provide summer fodder. Sudan grass (*Sorghum bicolor* (L.) Moench.) appears to have the potential to overcome the summer feed shortage. However, greater bility is required in the germplasm pool of Sudan grass to permit the selection of more productive forage lines. Irradiation has been reported by many authors to induce such plant variability in different plant species (Sax, 1963 and Ahmed, (1987). This study was initiated to determine the optimum treatments of irradiation needed to cause productive mutation in Sudan grass.

MATERIALS AND METHODS

These studies were carried out at the University of Agriculture, Faisalabad. Seeds of Sudan grass were subjected to nine treatments of chronic and acute gamma irradiation. The treatments were 10 kR (Kilo Rads), 20 kR, 30 kR, 40 kR, 50 kR, 60 kR, 70 kR, 80 kR, & 100 kR. The sources of radiation were 850 Curies 60Co gamma beam for chronic irradiation and 4,000 Curies 60Co gamma cell for acute irradiation. The treatments were applied at the Nuclear Institute for Agriculture and Biology, Faisalabad. Unirradiated seeds were used as a control sowing. Germination was tested in petri dishes with two replications in the laboratory. Twenty-five seeds were sown in each petri dish. The seeds were kept moist during the experiment. The germination percentage was recorded after five, seven and nine days after sowing. Seedling height (cm) was measured in petri dishes 9 days post-sowing.

A field trial was laid out in a completely randomized block design with three replications. Each plot consisted of two rows and the plot size was 3.9 m x 0.6 m. The irradiated and control seeds were sown in rows 30.5 cm apart into moist soil with a single row hand drill.

An additional irrigation was applied after complete germination. Thinning was performed 14 days after emergence in order to give a plant to plant distance of 22.5 cm. In order to examine the effects of irradiation on plant growth performance, germinatiqn percentage, seedling height, survival percentage, plant height, tillering capacity, and fresh and dry weight at maturity were measured. Ten plants were randomly selected in each line to monitor growth performance. They were labelled and kept under controlled conditions until harvest.

RESULTS AND DISCUSSION

The data for different characteristics of growth performance have been summarized in Tables 1 & 2 and statistical analysis is given in Table 3.

Germination: Highly significant differences were observed between the effects of irradiation on germination Percentage. The final average germination percentage in the irradiated lots was 46 as compared to 48 in the control and yet a suppressing effect was observed to be operating. At 7 days the germination percentage in the treated material (78-3%) was significantly lower than in the control (850%). However, by 9th day the treated material had almost the same germination percentage as that of the control. The experiments on germination percentage were conducted under optimum conditions for germination in the laboratory and the experiments were concluded on 9th day, when no further plants were emerging. For this study it was difficult to extrapolate this information to survival rate under field conditions. However, similar results in different crop

Table 1. *Mean values of germination percentage of Sudan grass (Sorghum bicolor (L.) Moench.), following chronic and acute gamma rays irradiation*

Treatments	Germination percentage after 5 days		Germination percentage after 7 days		Germination percentage after 9 days	
	Chronic	Acute	Chronic	Acute	Chronic	Acute
Control	40	58	94	76	96	80
10 kR	68	62	74	76	78	80
20 kR	26	32	84	68	84	82
30 kR	24	16	68	[illegible]	74	68
40 kR	58	48	68	76	88	80
50 kR	30	30	82	70	86	78
60 kR	34	60	92	80	92	86
70 kR	54	66	92	84	94	86
80 kR	64	74	74	80	80	84
100 kR	56	52	84	72	86	82

plants have been reported by other workers. Krishna *et al.* (1984) observed that seed germination in Rhodes grass (*Chloris gayana* Kunth.) was reduced at all doses of gamma rays except 10 kR where it was somewhat higher. He found no significant differences between 10 kR and 50 kR. Delayed germination was observed in Mexican wheat varieties after irradiation treatments of 20 kR, 25 kR, 50 kR and 75 kR.

Survival Percentage: In this experiment 80 kR and 100 kR proved to be lethal doses for Sudan grass. This may possibly be due to a higher frequency of chromosomal abberaiton and inhibition of the recovery mechanism by higher doses of radiation. Similarly, Johnstone and Klepinger (1967) found such treatments of irradiation to be lethal.

Seedling Height: Various levels of irradiation both in the chronic and the acute treatments significantly affected seedling height. The irradiation treatments depressed the growth of the seedlings. The seedling height in the 10 kR treatment did not differ significantly from the control. The higher doses of gamma irradiation reduced seedling height significantly. Maximum reductions in seedling height were found with 80 kR (2.65cm) and 100 kR doses (2.25cm) as compared to the control (12.97cm). Higher treatments of irradiation had an adverse effect on seedling height in the M-I generation. Similar results on different crop plants have been reported by Bottino and Sparrow (1971) and Krishna *et al.* (1984).

Plant Height: All doses of irradiation except 10 kR in both chronic and acute treatments reduced the final plant height, although the treatments from 10 kR to 50 kR were not statistically different from the control.

High level treatments (80 kR and 100 kR) proved to be lethal as none of the plants in these treatments survived. These treatments did not show such a drastic effect on germination and seedling height under the laboratory conditions, but the effect on seedling growth under field conditions was very severe A few seedlings which were stunted in the initial stages of growth ultimately died before maturity. Similarly, Bostrack and Sparrow (1970) suggested that an

Table 2. *Mean values of various morphological characteristics of sudan grass (sorghum bicolor (L.) Moench.) following chronic and acute gamma rays irradiation*

Treatments	Seedling height after 9 days (cm)		Plant height at maturity (cm)		Tillering capacity		Fresh weight (gm)		Dry matter weight (gm)	
	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Control	13.15	12.80	157.75	161.60	23.83	25.51	239.56	296.72	36.84	64.72
10 kR	12.20	12.65	155.87	170.81	32.10	23.63	436.10	345.86	81.26	78.42
20 kR	11.25	9.35	139.59	160.88	20.88	20.44	376.10	234.35	51.02	68.98
30 kR	10.65	9.20	186.45	149.71	25.81	21.45	368.06	264.59	73.70	81.73
40 kR	9.48	8.37	160.55	154.36	22.68	21.51	338.77	331.68	50.07	34.95
50 kR	6.30	8.50	159.41	148.05	20.60	22.70	284.43	331.68	63.30	47.24
60 kR	7.70	5.50	136.31	129.75	19.78	21.71	254.68	281.60	35.90	57.63
70 kR	4.15	4.28	122.40	116.35	19.58	21.72	261.75	339.71	26.45	51.02
80 kR	2.50	2.80	—	—	—	—	—	—	—	—
100 kR	2.55	1.94	—	—	—	—	—	—	—	—

Table 3. *Effect of chronic and acute irradiation on germination percentage of shdan grss (sorghum bicolor (L.) Moench)*

Sr. No.	Treatments	Significance level	Germinaion (%) after 5,7 & 9 days	Control
		Stat.Sign. at 5%	Stat. Sign. at 5%	
1	Control	73.66 ab	9 days 82.3 a	88
2	10 kR	69.66 ab	7 days 78.3 a	86
3	20 kR	62.66 b	5 days 46.0 b	48
4	30 kR	48.66 c		
5	40 kR	73.00 ab		
6	50 kR	62.66 b		
7	60 kR	74.00 ab		
8	70 kR	79.33 a		
9	80 kR	74.33 ab		
10	100 kR	72.00 ab		

CD1 = 12.74 CD1 = 6.584
CD2 = 16.94 CD1 = 8.756

-CD1 denotes critical difference at 5% level of significance.
-CD2 denotes critical difference at 1% level of significance.
-Averages followed by the same letters did not differ significantly ($p<0.05$) among themselves.

increase in plant height might result from low irradiation treatments in other crop species. At a very low dosage of irradiation, Ahmed (1987) found an increase in time for start of earing, plant height, leaves/plant, florets/spike, spike length and 1000 grain weight in wheat and barley varieties. In the present study, application of 10 kR treatment did increase the plant height ($P>0.05$).

Tillering Capacity: Number of tillers per plant play an important role in productivity, particularly in forage crops. Both chronic and acute treatments showed an appreciable effect on the average number of tillers per plant. The average number of tillers with 10 kR was higher (27.86) as compared to that of the control (24.67) but the difference was not statistically significant. Irradiation at higher levels showed a depressing effect on tiller number.

The maximum decrease in tiller number (20.6) was obtained with 70 kR compared to the control which produced (24.67) tillers per plant. These results are in agreement with those of Ghafoor *et al.* (1968) who reported an increase in the number of tillers in barley with irradiation.

Fresh Weight: Irradiation treatments seem to have very little effect on fesh weight as almost all the treatments showed results comparable to that of the control. It appears that radiation treatments do not affect the fresh weight to such an extent as was observed for germination percentage, seedling height and plant height. These findings are in agreement with those of Sax (1963) who observed increased growth from irradiation and concluded that these effects are probably due to the disruption of the auxin balance in plant.

Dry Matter Weight: In direct contrast to the fresh weight results, the analysis of variance for dry matter indicated a highly significant difference among treatments due to irradiation.

Lower treatments caused increase in dry matter production. The data indicated no differences in production among the control, 20 kR, 40 kR, 50 kR, 60 kR and 70 kR (50.78, 60.0, 42.5, 55.27, 46.76, and 28.73 gm) treatments respectively. Maximum dry matter weight of 79.84 gm per plant was obtained with 10 kR. The treatments of 40 kR, 60 kR and 70 kR reducen the dry matter content but the results were non-significant when compared with that of control. The effect of 70 kR treatment was significantly lower than 10 kR and 30 kR. Similar results have been reported by Sparrow (1966) who observed an increase in dry matter production with low treatments of irradiation. Ayub (1925) found that 20 kR treatment increased seed setting percentage in both wheat and barley varieties.

Chronic Versus Acute Irradiation : No differences were found in germination percentage, seedling height, plant height, tillering capacity, fresh weight and dry matter weight per plant between the chronic and acute gamma irradiation treatments in these studies.

These observations are in line with those of Sparrow (1965) who made comparisons acute and chronic exposures in various herbaceous plants and found no significant difference between chronic and acute treatments applied within the same species. of

Conclusions: The present study indicated that low treatments of gamma irradiation both chronic and acute had a stimulating effect on the tillering capacity and dry matter weight/plant in the case of Sudan grass. On the other hand, higher treatments such as 8) kR and 100 kR proved to be lethal as the plants in these treatments died before maturity.

Low treatments of gamma irradiation (10 kR to 30 kR) seemed to be promising for increasing genetic diversity within the germplasm pool of Sudan grass. This will enhance the chances of finding a line or series of lines adjusted to the environmental conditions in the province of Punjab (Pakistan).

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