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SHIFTING D_{50} AS A PARAMETER FOR RADIATION DAMAGE REPAIR IN *CICER ARIETINUM* L. cv. C-612.

K.A. Mujeeb and G.R Keerio

Plant Genetics Division, Atomic Energy Agricultural Research Centre, Tandojam, Sind, Pakistan.

Abstract

The morphological criterion estimated the seedling performance of *Cicer arietinum* L. cv. c-612 at three durations (15, 30 and 45 days from planting). The D_{50} values were 33, 5, 38.. 5 and greater than 40.0 kiloroentgens for each duration. The shifting D_{50} values have provided an interpolated measure of gamma irradiation damage recovery at 30 and 45 days to be 15 and greater than 19 percent, respectively.

Introduction

Mutagenic effects on biological material are most readily depicted by the early growth phases comprising of germination, seedling height and visual growth performance. Spaced observations of these aspects additionally provide evidence for radiation induced stimulation and damage recovery as assessed by shifting D^{50} values. This study has evaluated the growth response of *Cicer arietinum* L. cv. C-612 at three intervals upto 45 days from planting after acute gamma irradiation seed treatment.

Materials and Methods

One year old seeds of *Cicer arietinum* L. cv. C-612 obtained from Dokri Rice Research Institute, Dokri, Pakistan were used in this study. Samples of 400 seeds each were subjected to single gamma radiation exposures of 0, 5, 10, 15, 20, 25, 30, 35 and 40 kiloroentgens (kR.) from ^{60}Co source. The dose rate was 70 R minute.

The seeds were planted in the field immediately after irradiation. The randomized complete block design had five replications with 70 seeds per treatment per replication. Row to row distance was 2 feet and plant to plant 1 foot. The soil was fertilized prior to planting with a NPK dosage of 20: 30: 0 pounds per acre; nitrogen from urea (46% N) and phosphorus from triple super phosphate (46%).

Observations for germination, seedling height and visual growth rating (1 = poor, 2 = fair, 3 = average, 4 = good, 5 = excellent) were made at 15, 30 and 45 days from planting. Germination percentage and growth ratings were transformed (arcus sinus and square root) prior to analysis. From the germination and seedling height data extrapolations for seedling performance over the three time periods were made (Osborne & Lunden, 1961). Reversed logarithmic representation of this data gave D_{50} values that served for evaluating the initial radiation damage repair.

Results

INFLUENCE OF TIME ON GROWTH

The germination gradually progressed and the count at 30 days was significantly more than that at 15 days. Counts at 30 and 45 days remained similar (Table 1). Seedling height significantly increased over the three time periods (Table 2) but the visual growth ratings during this time remained similar (Table 3). The seedling performance values increased with time (Table 4) providing D_{50} values of 33.5, 38.5 and greater than 40.0 kR. for the three time periods.

INFLUENCE OF TREATMENTS ON GROWTH

A significant treatment effect on germination reduction was obtained only at 40 kR. (Table 1). Such reductions for overall growth and seedling height occurred from 15 and 30 kR. respectively (Tables 2 and 3). Though seedlings emerged earlier in 5 and 10 kR. this radiation induced stimulation was not carried over for significance of the trait when final observations were recorded.

Dosage and time interactions were nonsignificant in all cases (Table 1,2,3, and 4).

Discussion

Early germination at low dosages has been a stimulation phenomenon but has failed to manifest its significance with progressive growth for various crops (Stein & Richter, 1961; Mujeeb, 1972). Related initial results of inhibited or decreased germination and reduced growth characteristics with increased radiation exposures have

TABLE 1. Mean germination count over three time intervals after gamma irradiation seed treatment of *Cicer arietinum* L. cv. C-612.

	Dosages in kiloroentgens									
Days	0	5	10	15	20	25	30	35	40	Mean1
15	71	70	72	72	69	68	66	67	63	69a
30	74	73	75	77	72	73	72	72	69	73b
45	75	76	77	78	72	71	71	72	71	74b
Mean[2]	73a	73a	75a	76a	71a	71a	70a	70a	68b	

Means with same alphabet are not significantly different at $p > 0.05$.

1. Means for comparing days.
2. Means for comparing treatments.

TABLE 2. Mean seedling height (cms) over three time intervals after gamma irradiation seed treatment of *Cicer arietinum* L. cv. C-612.

	Dosages in kiloroentgens									
Days	0	5	10	15	20	25	30	35	40	Mean[1]
15	5.9	6.5	6.0	5.5	5.9	6.2	5.5	4.5	4.3	5.6a
30	12.8	12.5	12.4	12.5	12.4	11.7	11.4	11.2	10.2	11.9b
45	16.4	16.2	16.6	16.8	16.5	15.6	15.6	15.8	14.8	16.0c
Mean[2]	11.7a	11.7a	11.7a	11.6a	11.6a	11.1a	10.8b	10.5b	9.8c	

Means with same alphabet are not significantly different at $p > 0.05$.

1. Means for comparing days.
2. Means for comparing treatments.

TABLE 3. Mean growth ratings over three time intervals after gamma irradiation seed treatment of *Cicer arietinum* L. cv. C-612.

	Dosages in kiloroentgens									
Days	0	5	10	15	20	25	30	35	4*n*	Mean[1]
15	2.24	2.19	2.24	2.14	2.14	2.10	1.95	1.73	1.60	2.04a
32	2.24	2.24	2.24	2.24	2.19	2.14	2.04	1.84	1.72	2.09a
45	2.24	2.24	2.14	2.14	2.14	2.05	1.95	2.04	1.98	2.08a
Mnan[2]	2.24a	2.22a	2.21a	2.17b	2.16b	2.09c	1.99d	1.87e	1.70f	

Means with same alphabet are not significantly different at $p > 0.05$.

1. Means for comparing days.
2. Means for comparing treatments.

TABLE 4. Mean seedling performance over three time interval after gamma irradiation seed treatment of *Cicer arietinum* L. cv. C-612.

	Dosages in kiloroentgens									
Days	0	5	10	15	20	25	30	35	40	Mean[1]
15	100	108.9	104.0	96.9	98.0	100.7	86.5	73.2	64.2	81.8a
30	100	97.2	99.2	102.8	95.5	90.6	87.3	86.2	74.8	92.6b
45	100	99 7	104 5	106 8	97 5	90.2	89.5	92.5	85.2	96.2c
Means[2]	100a	101.9a	102.6a	102.2a	97.0a	93.8b	87.8c	84.0c	74.7d	

Means with same alphabet are not significantly different at p. $>$ 0.05.

1. Means for comparing days.
2. Means for comparing treatments.

been reported earlier; (Amer & Hakeem, 1964; Das & Mukherjee 1968; Goud *et. al.*, 1969; Bajaj *et. al.*, 1970; Ramulu, 1970; Mujeeb & Griegi 1973 a); similar to the present findings with *Cicer arietinum* L. cv. C-612. Mujeeb & Greig, 1972, 1973b, considered morpholcgical entities for estimating radiosensitivity (D_{50}) more variable, but Mujeeb (1972) further suggested that under some situations the criterion may have an advantage. Conger & Stevenson (1969) further considered seedling height as a valid indicator for evaluating radiation damage despite heterogeneity in treatment lots. Hence, where periodic estimations have to be made for characterizing initial radiation damage recovery, the seedling performance criterion seemed more readily applicable.

There are reports that ionizing radiations induce numerous cytological changes in plants of which impaired mitosis during germination of seeds irradiated at higher exposures was the most striking. (Gaul, 1964; Magri-Allegra & Zannone, 1965, Conger & Stevenson, 1969, Mujeeb & Greig, 1973 b). It may lead to virtual elimination of cell division in the meristematic zone without any apparent affect on cell expansion (Ananthaswamy *et. al.*, 1971), with growth in such cells being primarily attributed to elongation of cells pre-existing in the embryo at exposure time. Thus, biological damage in terms of seedling growth becomes more pronounced during the first few days. The shifting D^{50} from the radiosensitive (33.5 kR) to radio-resistant ($>$ 40 kR) values support the greater initial radiation damage and repair mechanism. Interpolating from the latter two D^{50} values at 30 and 45 days, the recovery percentages have been estimated as 15% and greater than 19% respectively. The differences were significant ($p > 0.05$).

The above periodic D^{50} estimation with *C. arietinum* L. cv. C-612 has assisted in formulating population treatment for the induced mutagenesis experiments, providing greater initial information of the spectrum of induced radiation damage and its manifestation.

References

Amer, S. and H.A. Hakeem. 1964. Studies on the effect of Co 60 gamma radiation on *Lupinus terminus*. Radiation Botany, **4**: 95-100.

Ananthaswamy, H.N., U.K. Vakil and A. Sreenivasan. 1971. Biochemical and physiological changes in gamma-irradiated wheat during germination. Radiation Botany, **11**: 1-12.

Bajaj, Y.P.S., A.W. Saettler and M.W. Adams. 1970. Gamma radiation studies on seeds, seedlings and callus tissue cultures of *Phaseolus vulgaris* L. Radiation Botany, **10**: 119-124.

Conger, A.D. and H.Q. Stevenson. 1969. A correlation of seedling height and chromosomal damage in irradiated barley seeds. Radiation Botany, **9**: 1-14.

Das, P.K. and S.K. Mukherjee. 1968. Effect of gamma radiation and ethyl methane sulphonate on seeds, cuttings and pollen in grapes. Ind. J. Genet. Pl. Br., **28**: 347-351.

Gaul, H. 1964. Mutations in plant breeding. Radiation Botany, **4**: 155-232.

Goud, J.V., K.M. Nayar and M.G. Rao, 1969. Radiosensitivity in ragi (*Eleucine coracana*). Can. J. Genet. Cytol., **11**: 254-265.

Magri-Allegra G. and L. Zannone. 1965. Effects of chemical and physical mutagens on forage vetch. 11. Comparison of chromosome aberrations produced by Ethyl methane sulphonate, ethylene imine and X-rays. Radiation Botany, (Supp.) **5**: 215-226.

Mujeeb, K.A. 1972. Seed radiosensitivity of some crops. Pak. J. Bot., **4**: 65-71.

Mujeeb, K.A. and J.K. Greig. 1972. Radiosensitivity of *Phaseolus vulgaris* L. cv. Blue Lake: Morphological and Physiological criteria. Radiation Botany, **12**: 437-439.

Mujeeb, K.A. and J.K. Greig. 1973 a. Gamma irradiation induced variability in *Phaseolus vulgaris* L. cv. Blue Lake. Radiation Botany, 13: 121—126.

Mujeeb, K.A. and J.K. Greig. 1973 b. Gamma radiation induced mitotic abnormalities of *Pisum sativum* L., as a measure of seed radiosensitivity. Cytologia, 38: 147—153.

Osborne, T.S. and A.O. Lunden. 1961. The cooperative plant and seed irradiation program of the University of Tennessee. Int. J. Appl. Radiation Isotopes, **10**: 198-209.

Ramulu, K.S. 1970. Mutations in *Sorghum*. Mutation Research, **10**: 197-205.

Stein, L.L. and R. Richter. 1961. The effect of X-irradiation in conjunction with red and far-red light on lettuce seed germination. In, Effects of ionizing radiation on seeds, I.A.E.A., Vienna, 197-199.