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Research Article

EFFECTS OF GAMMA RADIATIONS ON SEED GERMINATION AND MORPHOLOGICAL CHARACTERISTICS OF PEA (*PISUM SATIVUM* L.)

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ABSTRACT
The present study was conducted to determine the effects of gamma irradiation on seed germination and morphological traits of *Pisum sativum* L. For this purpose, dry and healthy seeds of *Pisum sativum* were exposed to different doses of gamma radiations viz.1kR, 5kR, 10kR, 15kR, 20kR, 25kR, 30kR, 35kR, 40kR and 50kR at the Bhabha Atomic Research Center (BARC). The result showed that the gamma irradiation affected germination percentage, plant survival and morphological characteristics such as plant height, pod number, pod length, seed number and grain weight. It was observed that all the trait showed decreasing trend in there mean value with the increasing intensity of gamma irradiation. However, in 10 kR irradiation dose showed the slightly increase in plant height with respect to control set. The highest doses of gamma rays such as 40kR and 50kR exposure caused death of all seedlings and no seed germination was observed.

Keywords: *Pisum Sativum, Gamma Radiation, Morphology*

INTRODUCTION
Pisum sativum L. belonging to the family Fabaceae is one of the most important vegetable in the world as well as in India. The plant has been widely grown as a cool season vegetable crop and consumed extensively worldwide as a rich source of protein, carbohydrates, vitamins and minerals important in human nutrition.
Pisum sativum is an annual plant, with a life cycle of two to four months. It has a unique ability to enrich the soil, like many legumes and contains symbiotic bacteria *Rhizobia* within root nodules.
Gamma rays are one of the most prominent ionization radiations that cause disruption of the normal processes of the cell ultimately affecting crop yield. The effect of these radiations is dose dependent, as these rays stimulate growth in plants at low dose (Safadi and Simon, 1990).
These radiations cause changes in the physiology, morphology, anatomy and biochemistry of the plants (Kim *et al.,* 2004). In plant improvement programs the irradiation of seeds may cause genetic variability that may enable plant breeders to select new genotypes with improved characteristics such as precocity, salinity tolerance, grain yield and quality (Ashraf *et al.,* 2003). Gamma radiation can be also useful for the alteration of physiological characters (Kiong *et al*., 2008). This present study was conducted to determine the effects of gamma radiation on *Pisum sativum* with respect to seed germination and some physiological characteristics.

MATERIALS AND METHODS
Plant Material
The dry and healthy seeds of local cultivar of *Pisum sativum* have been used in the present study. The seeds were exposed to different doses of gamma rays (Viz. 1kR, 5kR, 10kR, 15kR, 20kR, 25kR, 30kR, 35kR, 40kR and 50kR) at Bhabha Atomic Research Center, Mumbai. After irradiation, fifty seeds of each dose were sown in pots, ten in each pot. Data was calculated on morphological traits such as seed germination, plant survival, plant height, pod number per plant, pod length, seed number per plant and seed weight and compared with control. The data on seed germination and morphological was recorded right from the seedling stage in each treatment, include in control. Mean germination percentage was determined by counting the seedlings emerged in each pot per total number of seeds sown multiplied by hundred.

Plant Height (cm)

Seedling height was measured on 60th day of germination by measuring the irradiated and non-irradiated randomly selected samples from each treatment. The height was measured from the base of the plant to the tip of flag leaf. For collecting the data of the other parameters, the sample plants of each treatment were randomly selected and the recorded data was subjected to statistical analysis to assess the extent of induced variations. Standard deviation was computed by applying the following formula.

$$SD = \sqrt{\frac{1}{n}\sum\left(X_i - \overline{X}\right)^2}$$

Where $\overline{X}$ = Mean of observations involved
X*i* = Observations
n = Number of observation

RESULTS AND DISCUSSION

Seed Germination and Plant Survival Percentage

The data on seed germination and plant survival percentage was summarized in Table 1. Seed germination was observed at 6th day in control and treated plants. The germination percentage decrease with increase of gamma ray exposures; the germination percentage for the control group was 100%, while for the treatment groups was 92% for 10kR, 62% for 20kR, 36% for 30kR and finally the lowest 22% for 35kR (Table 1).

The survival percentage also decrease with increase of gamma ray exposures, the survival percentage was recorded in control 100% but for treatment ones, survival percentage was 89.13% for 10 kR, 64.51% for 20 kR, 44.44% for 30 kR and finally the lowest 36.36% for 35 kR (Figure 1).

The lethal dose where the 100 percent of germination is inhibited was identified at the gamma dose 40 and 50 kR.

Several reports on the stimulative effects of gamma radiation that affect seed germination and plant survival were reported by Ahmed and Qureshi, (1992); Majeed *et al.,* (2010); Borzouei *et al.,* (2010); Cemalettin *et al.,* (2006).

The results of Kiong *et al.,* (2008) have shown that survival of plants to maturity depends on the nature and extent of chromosomal damage. Increasing frequency of chromosomal damage with increasing radiation dose may be responsible for less germination ability and reduction in plant growth and survival. In present study results showed the adverse effect of gamma rays on seed germination and plant survival.

Table 1: Effect of Various Doses (kR) of Gamma Irradiation on Percentage of Seed Germination and Plant Survival in *Pisum Sativum* L

Treatment Dose	Number of Seeds Sowed	Seed Germination		Plant Survival	
		No.	%Age	No.	%Age
Control	50	50	100	50	100.00
1kR	50	49	98	45	91.83
5kR	50	48	96	43	89.58
10kR	50	46	92	41	89.13
15kR	50	41	82	35	85.36
20kR	50	31	62	20	64.51
25kR	50	23	46	12	52.17
30kR	50	18	36	08	44.44
35kR	50	11	22	04	36.36

Table 2: The Plant Height, Pod Number/Plant, Pod Length (cm), Seed Number Per Plant, and 100 Seed Weight of *Pisum Sativum* at Various Doses of Gamma Radiation
SD = Standard Deviation

Treatment Dose	Plant Height (cm) (Mean±SD)	Pod Number/Plant (Mean±SD)	Pod Length (cm) (Mean±SD)	Seed Number/Plant (Mean±SD)	100 Seed Weight (gm) (Mean±SD)
Control	60.3 ±5.38	21.2±2.64	5.26±0.28	41.8±4.12	16.05±0.46
1 kR	62.5 ±5.83	19.6±1.43	5.11±0.28	37.9±4.28	16.12±0.26
5 kR	64.1 ±5.90	18.1±4.99	4.94±0.33	35.5±2.97	15.65±0.53
10 kR	67.6 ±3.00	16.1±2.91	4.83±0.40	33.7±2.79	14.81±0.52
15 kR	62.4 ±4.45	15.8±3.31	3.99±0.31	31.5±2.11	14.34±0.72
20 kR	60.2 ±4.44	14.1±2.62	3.11±0.56	29.7±3.85	13.74±0.82
25 kR	57.3 ±6.01	13.3±2.65	2.95±0.33	18.3±2.28	13.25±0.74
30 kR	55.3 ±4.24	11.3±1.35	2.67±0.25	14.9±1.70	11.60±1.43
35 kR	53.8 ±2.35	10.5±2.01	2.34±0.20	7.60±2.06	10.47±0.35

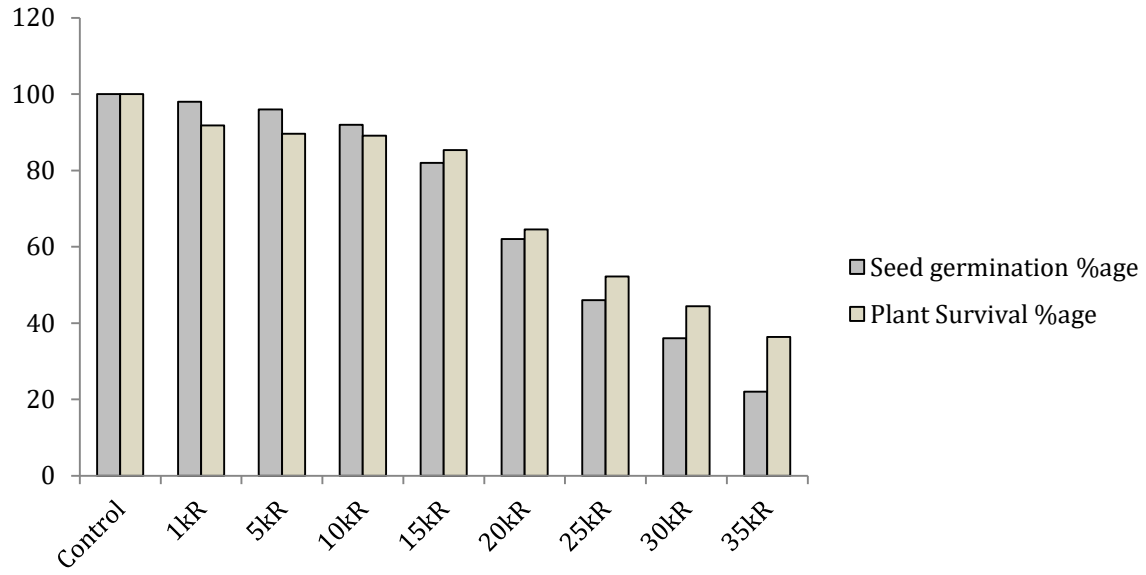

Figure 1: Effect of Gamma Radiations on Seed Germination and Plant Survival of *Pisum Sativum*

Effect of Gamma Irradiation on Plant Height (cm)
Effect of gamma irradiation on average plant height of 60-day-old *Pisum sativum* was measured in the control (Figure 2) and irradiated experimental groups. Table 2 shows the average mean plant heights of the control was 60.3 cm and that of plants exposed to 1, 5, 10, 15, 20, 25, 30 and 35 kR gamma irradiation were 62.5, 64.1, 67.6, 62.4, 60.2, 57.3, 55.3 and 53.8 respectively. The highest plant height 67.6 cm was observed in 10 kR (Figure 2) which may be due to stimulatory effect of irradiation treatment. In general, the average plant height was reduced with the increasing treatment doses. All the doses showed decrease in the average mean plant height and showed inverse proportionality to the radiation intensity. Irfaq & Nawab (2001) and Chaudhary (2002) reported decrease in average plant height in response to gamma irradiation.

Effect of Gamma Irradiation on Pod Number Per Plant
The effect of different doses of gamma rays was observed for pod number per plant (Table 2) on *Pisum sativum*. The mean value of pod number in control was observed (21.2) and other irradiated doses, showed the mean value of pod number decreased with increasing irradiation doses (Figure 2). In present

study, the higher exposer of gamma rays affected the total number of pods per plant. Similar results were reported by Choudhary and Agrawal (2014).

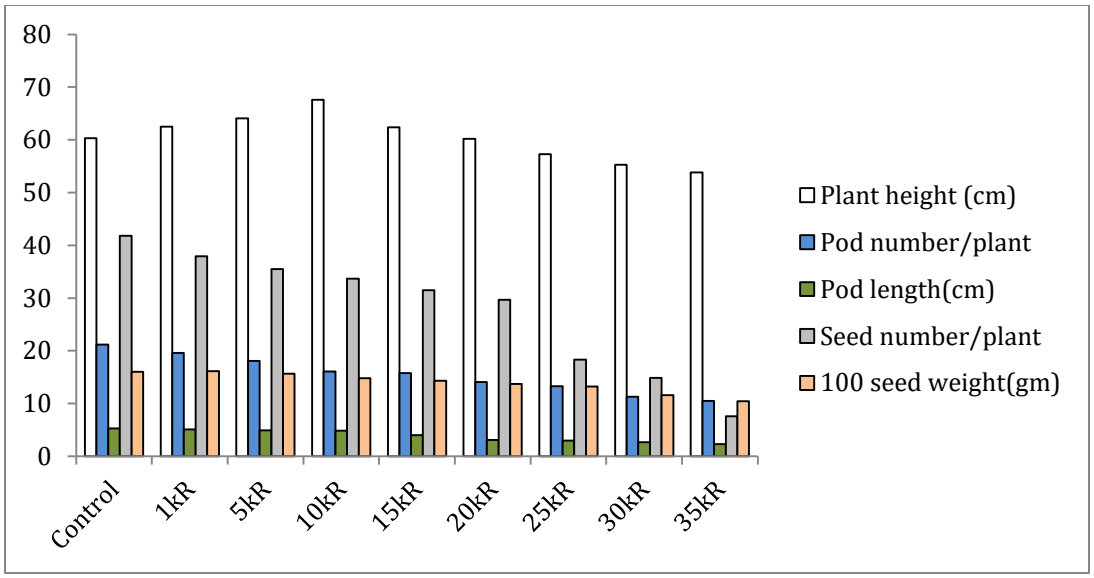

Figure 2: Effect of Gamma Radiations on Various Morphological Traits of *Pisum Sativum*

Effect of Gamma Irradiation on Pod Length (cm)

After the ripening of fruits, length of pods were measured and compared with the control population (Figure 2). The mean number of pods length showed constant decrease with the increasing dose of gamma rays.

The highest (5.26) mean value of pod length was measured in control and the lowest (2.34) mean value of pod length was noticed in 35kR treated plants of gamma radiations (Table 2). Similar result was reported by Shamsi and Sofajy, (1980).

Effect of Gamma Irradiation on Seed Number/Plant

The maximum mean value of seed number was measured in control (41.8) followed by gamma irradiation dose 15 kR (31.5) and finally the lowest mean value of seed number (7.60) at 35kR (Table 2). The number of seeds per plant was affected by various exposures of gamma rays with compared to control (Figure 2). Irfaq & Nawab (2001) observed the regular decrease in the trait with the increasing intensity of gamma radiations.

Effect of Gamma Irradiation on 100 Seed Weight (gm)

Different exposures of gamma rays shows continuously decrease (Figure 2) in the mean values of the seed weight. In the present study the maximum decrease in the average values of grain weight was observed at 35kR of radiation dose (10.47) with respect to control (Table 2). The same result was observed by Irfaq and Nawab (2001). However, Khah and Verma (2015) observed increase in the average 100 seed weight at 15 kR radiation dose in there study.

Conclusion

Gamma rays are a type of ionizing radiation that can affect plant growth and cause to produce mutation in plants with specific abnormalities. Different doses of gamma rays exposure are very in affecting germination and plant growth of *Pisum sativum*. When the doses are increased, it gives a decline in germination and survival rate. Higher doses of gamma rays such as 25 kR to 35 kR affected the plant growth and plant became stunted and very slow. However, in lower dose (10kR) the highest plant height was observed which may be due to stimulatory effect of irradiation treatment. Doses of gamma rays could also produce mutants with abnormalities such as a dwarf plant, the wrinkled and crumpled leaves and the bent stems.

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