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EFFECT OF GAMMA IRRADIATION ON SEED GERMINATION AND SEEDLING GROWTH OF *CAPSICUM ANNUM* L.

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ABSTRACT:
This study was conducted to investigate the effect of seed irradiation on the seed germination and seedling growth characteristics of two varieties of *Capsicum annum.* variety Pusa Jwala and variety Bhiwapuri. Seeds were irradiated with 100,200,300,350& 400Gy gamma rays using Cobalt-60. Percentage of seed germination and growth traits such as seedling height, root length and leaf number were observed. Results showed that irradiation dose at 400Gy had highest lethal effect. Germination percentage in both the varieties decreased with increasing dosage of gamma irradiation from 200Gy to 400Gy in petri-dish method and 100Gy to 400Gy in raised bed method. Growth in terms of seedling height and root length decreased with increasing doses of gamma irradiation in both the varieties. Leaf number significantly decreased in 300, 350 and 400Gy of Bhiwapuri and in 350 and 400Gy treatments of Pusa Jwala.

Key words: - *Capsicum annum; Gamma rays; Induced mutation*

INTRODUCTION:

Chili (*Capsicum* spp.) of family Solanaceae is an important spice and vegetable crop grown in Asia, Africa, and South America (Pakdeevaranporn et al. 2005). Among the five-cultivated species of chili, *Capsicum annuum* is the most widely cultivated species in India for its pungent (chili syn. hot pepper) and non- pungent (sweet pepper syn. bell pepper) fruits. The cultivation of *C. frutescence, C. Chinese and C. baccatum* is limited and usually restricted to homestead gardening in different regions (Reddy *et al.* 2014).

Mutation is a sudden heritable change in an organism (Soeranto et al. 2011; Dhanavel et al. 2012). Qualitative and quantitative characters can change through induced mutation (Muduli & Misra, 2007). One of the most important physical mutagens is the ionizing radiation- gamma rays. The free radicals formed by ionization cause damage to the living cell and affect the morphology, anatomy and physiology of plants depending on irradiation dosage (Kim et al. 2004).

More than 3,200 officially released crop varieties have been developed through induced mutation strategies in over 80 years (Mba, 2013). According to the FAO/IAEA database, more than half (60%) of the mutant-derived varieties were developed in Asia, followed by Europe (30%), Latin America, and the Caribbean, while North America and Africa contributed 2% each. Moreover, in an officially released database of mutant varieties by Joint FAO/IAEA, cereals contributed almost (48%) of all mutant crop varieties globally, followed by ornamentals (20%), legumes and pulses (14%), trees (3%), vegetables (3%), forage (3%), fiber crop (2%), root (1%) and others (3%) (Mba, 2013). Mutation has played a vital role in the improvement of crop productivity and quality, resultantly >3,000 varieties of 175 plant species

have been developed either through direct or indirect mutation breeding approaches worldwide. (Mir et al. 2020).

The effectiveness and efficiency of gamma rays and ethylmethansulphonate (EMS) for inducing mutation in chili were studied. Lethality or biological injury, apparent as reduced germination, increased with increasing doses of gamma rays and EMS. Morphological mutants, chlorophyll mutants were observed (Sridevi & Mulliainanthum, 2011). The LD50 dose for Tomato cultivar Patharkutchi and Alisa Craig was 310.7 and 229.7 Gy gamma ray, 0.30% and 0.20% EMS concentration, respectively. Gamma ray 50Gy to 150Gy proved to be more efficient and effective mutagen followed by 0.05% to 10% EMS treatment (Sikder et al. 2015). Gamma ray induced meiotic abnormalities in *Capsicum annuum* L (Rao & Lakshmi, 1980), Germination percentage, seedling root length, seedling shoot length, speed of emergence, and seedling vigour index decreases with increasing doses of gamma rays and EMS in *Capsicum annuum* L. (Sood et al. 2016). Gamma irradiation induced chromosomal abnormalities in *Capsicum annum* L. (Verma et al. 2017).

As a result of induced mutation and improved management and agronomic inputs over the past years, significant increase in the yield of major crops including chili varieties have reported (Swaminathan et al.1998). Gamma irradiation induced resistance against Begomovirus in *C. annum* (Gaswanto et al. 2016). Chlorophyll mutants were induced in *C. annum* L. through gamma irradiation and ethyl methane sulphonate (Gaur et al. 2013). Morphological characters of seedlings with treated seeds varies from control (Orapin et al 2020) seeds of irradiated seeds irradiated Gamma rays can be used for alternative for crop improvement (Friebe et al.1991). The aim of present investigation is to study the effect of gamma irradiation on seed emergence and seedling growth of the *C. annum* L.

MATERIALS AND METHODS

A. Plant material: In the present investigation, physiologically similar seeds of chili variety Pusa Jwala and Local Bhiwapuri were obtained from certified dealers and Local chili growers respectively.

B. Gamma Irradiation: Seeds of both the varieties were irradiated with 100Gy, 200Gy,300Gy,350Gy 400Gy doses of gamma rays from ^{60}Co at Department of Botany, Rashtrasanta Tukdoji Maharaj, Nagpur University, Nagpur, Maharashtra. The seed germination and seedling growth experiments were undertaken at Department of Botany, Anand Niketan College, Warora, Maharashtra.

C. Seed Germination: Seed germination was tested by two methods. In first method, 50seeds of each dose along with control were kept in petri dishes on germination paper in triplicates. The emergence of radical was taken as indication for germination of seeds. In second method, 30 seeds of each dose along with control were sown in a pot filled with soil and manure. Germination percentage was calculated by counting the germinated seeds and total number of seeds sown. During M1 generation following parameters were also studied after 30 days of sowing.

D. Seedling Height (cm): Seedling height was recorded with the help of scale.

E. Root Length (cm): Plants were uprooted carefully without damaging the roots and measured.

F. No. of Leaves: Total number of leaves were counted.

G. Statistical Analysis: Statistical analysis was performed by ANOVA.

RESULT & DISCUSSION :

The present study was done in chili variety to access the effect of gamma irradiation.

Seedling emergence in M1 was recorded after 6 to 12 days of sowing in Petri dish and raised bed method. In Petri dish method, germination percentage in 100Gy of Bhiwapuri cultivar was slightly more (92%) as compared to control (90 %) indicating stimulatory effect. This stimulatory effect may be due to activation of cell division and growth hormones (Zaka et al. 2004). But no such effect on germination was seen in Jwala. After 100Gy, germination percentage decreased with the increasing dosage of gamma irradiation in both the cultivars. Lowest germination occurred in 400Gy (78%), over control (90%) in Bhiwapuri and 78.66% over control (100%) in Jwala.

In Raised bed method, germination percentage decreased with the increasing dosage of the gamma irradiation. Lowest germination occurred in 400Gy (52.66%), over control (88%) in Bhiwapuri and 28% over control (100%) in Jwala Table 1 Average seedling height, in root length and leaf numbers in Jwala were recorded after the 30days of sowing on raised bed. Seedling height decreased with increasing dosage of the gamma irradiation. Lowest height was measured in 400Gy (8.32cm) as compared to control (11.68cm) in Bhiwapuri and in 400Gy and as (4.31cm) compared to control (12.70cm). In Jwala root length decreased with increasing dosage of the gamma irradiation. Lowest root length measured in 400Gy (3.34cm) compared to control (4.15cm) in Bhiwapuri and in 400Gy (2.56cm) compared to control (6.54cm) in Jwala. Leaf number decreased with increasing dosage of the gamma irradiation. Lowest leaves number was found in 400Gy (6.23cm) as compared to control (8.19 cm) in Bhiwapuri and in 400Gy (4.12cm) compared to control (6.70cm) in Jwala.

Results showed that dosage of 400Gy drastically reduced seed germination and growth characteristics of seedlings in both the cultivars. The gamma irradiation dosage negatively affects the germination percentage in chili (Lopez-Mendoza H & Carrilo-Rodriguez C, 2012). Chili seeds treated with higher dosage of gamma irradiation shows poor growth compared to control (Omar *et al.*2008). Physiological damage caused by gamma irradiation directly correlates with mutation frequency. Mutation frequency in an organism increases with the increasing dosage (Dhanavel *et al.* 2012). The present results are in tune with these earlier reports.

CONCLUSION:

Irradiation dosage of 100Gy, 200Gy, 300Gy, 350Gy and 400Gy induced morphological variability in both the varieties. From the above observation, it is clear that not all dosage of gamma irradiation is lethal. Also, lethality varies in different varieties of *C. annum.* gamma irradiation can be used to induce genetic variability in *C. annum* in order to improve the crop and to cross the barriers in cross breeding.

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Table 1:Germination percentage of both the varieties of chili using two methods

Methods	Chili Varieties		Dosage				
		Control	100Gy	200Gy	300Gy	350Gy	400Gy
Petri dish	Bhiwapuri	90	92(+2.22)	88(-2.2)	88(-2.2)	85.33(-5.18)	78(-13.33)
	Jwala	100	100(±0)	98(-2)	96(-4)	92(-8)	78.66(-21.34
Raised bed	Bhiwapur	88	89.33(-1.51)	82.66(-6.06)	80.66(-8.34)	68.66(-21.97)	52.66(-40.15)
	Jwala	100	94.66(-5.34)	84.66(-15.34)	76.66(-23.34)	67.62(-32.38)	28(-72)

Table 2a:Seedling Height in Bhiwapuri

Chili Variety		Dosage				
Bhiwapuri	Control	100Gy	200Gy	300Gy	350Gy	400Gy
Average Height (cm)	11.68	11.63	10.49	9.46	9.05	8.32
Standard Deviation (SD)	1.19	1.13	1.13	1.06	0.52	0.74
Standard Error (SE)	0.13	0.12	0.12	0.11	0.06	0.12

Table 2b:Seedling Height in Jwala

Chili Variety		Dosage				
Jwala	Control	100Gy	200Gy	300Gy	350Gy	400Gy
Average Height (cm)	12.70	9.53	8.22	7.26	8.86	4.31
Standard Deviation (SD)	0.54	0.64	0.70	0.74	0.92	0.67
Standard Error (SE)	0.05	0.06	0.07	0.09	0.13	0.18

Table 3a:Root Length in Bhiwapuri

Chili Variety		Dosage				
Bhiwapuri	Control	100Gy	200Gy	300Gy	350Gy	400Gy
Average Root Length (cm)	4.15	4.00	3.98	3.88	3.78	3.34
Standard Deviation (SD)	1.35	1.36	0.85	0.56	0.40	0.48
Standard Error (SE)	0.30	0.31	0.18	0.13	0.09	0.12

Table 3b:Root Length in Jwala

Chili Variety		Dosage				
Jwala	**Control**	**100Gy**	**200Gy**	**300Gy**	**350Gy**	**400Gy**
Average Root Length (cm)	6.54	6.32	3.95	3.67	2.72	2.56
Standard Deviation (SD)	0.42	0.57	0.54	0.32	0.24	0.28
Standard Error (SE)	0.10	0.13	0.13	0.07	0.06	0.07

Table 4a: Leaf Number in Bhiwapuri

Chili Variety		Dosage				
Bhiwapuri	**Control**	**100Gy**	**200Gy**	**300Gy**	**350Gy**	**400Gy**
Average Leaf Number	8.19	7.90	7.95	6.47	6.38	6.23
Standard Deviation (SD)	0.60	0.70	0.66	0.81	0.58	0.58
Standard Error (SE)	0.13	0.15	0.14	0.17	0.12	0.12

Table No.4b: Leaf Number in Jwala

Chili Variety		Dosage				
Jwala	**Control**	**100Gy**	**200Gy**	**300Gy**	**350Gy**	**400Gy**
Average Leaf Number	6.70	6.54	6.41	6.25	6.12	4.12
Standard Deviation (SD)	0.75	0.65	0.65	0.53	0.33	0.53
Standard Error (SE)	0.15	0.13	0.13	0.10	0.06	0.10