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Studies on Induced Mutations in Onion: Frequency and Spectrum of Chlorophyll mutations

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ABSTRACT: The seeds of onion (*Allium cepa* L) var. N-2-4-1 were treated with different doses/concentrations of gamma radiation and sodium azide, alone and in combinations. Mutagenic treatments resulted in induction of four types of chlorophyll mutants like striata, chlorina, xantha and albina in M_2 generation. Among all the treatments, combination treatments were more effective to induce chlorophyll mutations. In comparison with physical and chemical mutagens, gamma radiation was more effective than the sodium azide. Among four types of chlorophyll mutants, albina types of chlorophyll mutants were highest in percentage while striata type of chlorophyll mutants was very low in percentage.

Key words: Onion, Sodium azide, gamma radiation, combination treatments, chlorophyll mutants

INTRODUCTION

Onion (*Allium cepa* L) is economically important vegetable, widely used in all parts of the world. It is a source of foreign currency for the country. In onion, yield is inversely proportional to the Total Soluble Solids (McCollum 1968) and 40-100% storage losses within 6-months (Musa et al., 1973). Induced mutations are known to be useful to solve specific problems in crop and it is also helpful to break undesirable linkage between two characters. Hence, the present investigation was aimed solve these speific problems with the help of induced mutations.

In India, the research work on induced mutations in onion is very scanty. The role of induced mutations in improvement of onion have been confirmed (Kataria and Singh 1989). Four mutant varieties namely Compas, Brunette, KIK-11 and KIK-13 were released for the cultivation in Netherlands and Russia (Maluszynski et al 2000). The improved characters are earliness, stiffness and yield. Present research paper deals with the studies on induced chlorophyll mutations by gamma radiation and sodium azide, alone and in combinations.

Since the pioneering work of Stadler (1928), chlorophyll mutations have been used to estimate the frequencies of induced mutations. Chlorophyll mutations are important parameter, which are used to estimate the effectiveness of the mutagens. It is also the indication of factor mutations.

MATERIALS AND METHODS

The seeds of onion var. N-2-4-1 obtained from National Research Center for Onion and Garlic, Rajgurunagar, Dist. Pune were treated with sodium azide (0.1, 0.3, 0.5 & 0.7%) and gamma radiation (2,4,6,8,10 &12kR). For combination treatments dry seeds were firstly exposed to different doses of gamma radiation and then presoaked seeds were treated with different concentrations of sodium azide. Seeds were immediately sown in experimental field of NRC, Onion and Garlic, Rajgurunagar, Dist. Pune. After seedling transplantation, bulbs were harvested. Randomly selected bulbs from each treatment and control were used for seed production. Each plant was bagged to avoid cross-pollination. Umbel stalks were shaken for each and every day manually for artificial pollination. Seeds were harvested separately from each plant, stored in paper bags and used for M_2 generation.

Scoring of chlorophyll mutations: Collected seeds were sown to rise M_2 generation and the population was screened keenly for different types of chlorophylls mutations. The frequency and the spectrum of mutations were calculated. The identification and classification procedure for chlorophyll mutations was followed (Gustafson 1940). The frequency of chlorophyll mutations was classified according to Gual (1960) i. e. Number of mutants/100 M_2 plants.

RESULTS AND DISCUSSION

Chlorophyll mutations in M_2 generation had been proved to be the most dependable indices for evaluating the genetic effects of mutagenic treatments. (Gustafson and Von-Wettstein, 1956).

In present investigation, the four different type's viz. striata, chlorina, xantha and albina of chlorophyll mutations were observed. The frequency of total chlorophyll mutants varied for single as well as combined mutagenic treatments of gamma radiation and sodium azide.

The results on chloroplyll mutations induced by various chemical and physical mutagens, alone and in combinaton, were recorded by various workers (Mahamune and Kothekar 2012, Girija and Dhanavel 2013, Ramezani and More 2014).

For the single mutagenic treatment of sodium azide, the percentage of total chlorophyll mutations increased as concentrations of sodium azide increases. The percent chlorophyll mutations in sodium azide were ranges from 2.81% to 5.75%. The average frequency was 4.46%. Among all the total chlorophyll mutations, the higher percentage (3.59%) was showed by striata type of chlorophyll mutation in 0.7% sodium azide treatment. While chlorina type of mutation was 3.26% at 0.5% sodium azide. Overall, the xantha and albina showed very low percentage of total chlorophyll mutation as compared to striata and chlorina. The results on the induction of chlorophyll mutations due to sodium azide was reported (Makeen et al 2013 and Lal *et al.,* 2009) in black gram.

Due to the gamma radiation dose treatments, the highest percentage of chlorophyll mutations was 27.22%, which was higher than sodium azide. The highest chlorophyll mutations were in 12kR dose treatment.

Table 1: Effect of sodium azide and gamma radiations on the frequency and spectrum of the chlorophyll mutants in M_2 generation of onion (*Allium cepa* L.) var. N-2-4-1.

Mutagen	Treatments conc./dose (%, kR)	% Chlorophyll mutations	Striata	Xantha	Chlorina	Albina
			%	%	%	%
Sodium azide	0.1	2.81	0.65	0.43	1.73	-
	0.3	3.73	1.49	-	2.23	-
	0.5	5.55	2.94	-	3.26	0.32
	0.7	5.75	3.59	0.35	2.15	-
	Average	**4.46**				
Gamma radiations	2	4.66	2.0	1.55	0.23	0.88
	4	8.74	2.82	2.31	1.79	1.79
	6	16.44	3.50	6.19	2.42	4.31
	8	22.19	3.93	8.42	4.21	5.61
	10	24.19	4.03	9.67	4.83	5.64
	12	27.22	4.45	11.38	5.44	5.94
	Average	**17.24**				

Table 2: Effect of combination treatments of gamma radiations and sodium azide on the frequency and spectrum of the chlorophyll mutants in M_2 generation of onion (*Allium cepa* L.) var. N-2-4-1.

Mutagen	Treatments Dose/conc. (kR, %)	% Chlorophyll mutations	Striata	Xantha	Chlorina	Albina
			%	%	%	%
Gamma radiation + Sodium azide	2+0.1	09.53	1.83	3.07	3.07	1.84
	2+0.3	12.26	2.46	3.34	3.34	1.48
	2+0.5	15.67	2.60	-	-	5.94
	4+0.1	08.83	-	1.99	1.99	1.70
	4+0.3	14.18	3.80	2.07	2.07	2.07
	4+0.5	16.56	4.29	2.45	2.45	3.06
	6+0.1	16.82	5.14	-	-	5.14
	6+0.3	23.40	7.44	9.04	9.04	-
	6+0.5	32.71	8.64	9.87	9.87	6.79
	8+0.1	18.43	4.46	6.70	6.70	7.26
	8+0.3	25.15	6.74	-	-	12.88
	8+0.5	29.78	8.51	-	-	13.47
	Average	**19.44**				

The values of chlorophyll mutations were ranging from 4.66% to 27.22%. The average frequency was 17.24. Among all types of chlorophyll mutations, xantha and albina types of mutants showed higher percentage (11.38 and 5.94 respectively) followed by chlorina (5.44) and striata (4.45). Chlorophyll mutations induced by gamma radiation was reported (Girija and Dhanavel 2013 in Cowpea and Mishra et al 2013 in green gram). In present investigation, due to gamma irradiation dose treatments, xantha mutants were obtained in maximum percentage followed by albina, chlorina and striata.

In present investigation, it was noted that gamma radiation was effective than sodium azide for the induction of chlorophyll mutations. This was supported by Warghat *et al.,* (2011).

The combined treatments were showed wide range of total percentage of chlorophyll mutations. The range varied from 9.53% to 32.71% while average frequency was 19.44. Highest chlorophyll mutations were in 6kR + 0.5% SA treatment (32.71%). There was no linear increase in the percentage of total chlorophyll mutations. But if gamma radiation dose combined with different concentrations of sodium azide, as the concentration of sodium azide increases, total chlorophyll percentage was increases. The values were 15.67%, 16.56%, 32.71%, and 29.78% at the treatments such as 2+0.5 SA, 4+0.5 SA, 6+0.5 SA and 8+0.5 SA.

Induced chlorophyll mutations due to combination treatments of mutagens were reported by various workers (Yadav *et al.,* 2000 in Indian mustard, Khan and Tak 2000 in black gram , Wani and Anis 2004 in gram, Lal *et al.,* 2009) in black gram.

In present investigation, the chlorophyll mutations were increased up to 6kR+0.5% SA and it declined further. This indicates the saturation effects of the higher treatments. Similar results were reported by Sreekantaradhyay and Madhavamenon (1979) in Sorghum. Nilan and Konzak (1961) have also reported the diversity of chlorophyll mutations to intergenic effects of radiation.

Regarding the spectrum of chlorophyll mutations due to the combined treatments, albina were recorded in higher while striata type of chlorophyll mutants were noted in very low percentage. Reddi and Rao (1988) supported the above trend in onion.

The overall trend of treatments was recorded in present investigation was as follows - Combined treatments > Gamma radiation > Sodium azide. These results revealed that combination treatments were more effective than the single treatment, which was in conformity with Wani and Anis (2004), Makeen et al (2013) and Ramezani and More (2014).

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