Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 8, Issue, 07, pp.33953-33957, July, 2016

ISSN: 0975-833X

RESEARCH ARTICLE

INDUCED MUTAGENESIS IN PIGEON PEA [*Cajanus cajan* (L.)Millsp.]

*Sangle, S. M.

Department of Botany, Dada Patil Mahavidhyalaya, Karjat, Ahmednagar-414402(M.S.)

ARTICLE INFO

Article History:
Received 21st April, 2016
Received in revised form
05th May, 2016
Accepted 14th June, 2016
Published online 16th July, 2016

Key words:

EMS, Gamma rays, SA, Mutant.

ABSTRACT

The mutagenic effects of Gamma rays, EMS and SA on frequency, spectrum and relative percentage of promising mutant in two varieties of pigeon pea viz. BDN 708 and BSMR 853 have been studied. These varieties showed differential response to mutagens. In morphological mutants tall, dwarf, small compact leaves, small pod, five seeded pod, two seeded pod and branched were isolated. Majority of such mutants bred true during the subsequent generation. The wide range of variability for yield contributing characters was observed.

Citation: Sangle, S. M. 2016. "Induced mutagenesis in pigeon pea [*Cajanus cajan* (L.)Millsp.]", *International Journal of Current Research*, 8, (07), 33953-33957.

INTRODUCTION

Pigeon pea [*Cajanus cajan* (L.)Millsp.] popularly knows as tur, arhar or red gram is an important pulse crops of tropics and subtropics. Pigeon pea is used in a wide variety of ways. Its main use in the Indian subcontinent is as human food. The dry seed is dehulled and the split cotyledons that are called as dhal are cooked to make a thick soup primarily for mixing with rice. This is the way generations of Indian people on the subcontinent have used pigeon pea for over 2000 years. Induced mutations provide an important source for variability. The present investigation was undertake to study the mutagenic effects of Gamma rays, Ethyl Methane Sulphonate (EMS) and Sodium Azide on induced variations in frequency, spectrum and relative percentage of viable mutants M_2 generation in pigeon pea.

MATERIALS AND METHODS

The experimental plant material used in the present investigation comprised two varieties of pigeonpea [*Cajanus cajan* (L.) Millsp.] namely, Amol (BDN-708) and Vaishali (BSMR-853). The varietal material was obtained from the Agricultural Research Station, Badnapur, Dist. Jalna. (Under Marathwada agriculture university Parbhani, M.S. India). The chemical mutagens namely, ethyl methanesulphonate (EMS) and sodium azide (SA) besides physical mutagen gamma rays were used in the present study. Healthy and dry seeds of the both varieties of pigeon pea having uniform size and equilibrated to a moisture level of 10 percent were packed in small polythene covers and exposed to doses like 5kR, 10kR and 15kR of gamma rays. Uniform seeds of two pigeon pea varieties were surface sterilized with 0.1 % mercuric chloride solution for about one minute and washed meticulously with distilled water. They were presoaked in distilled water for 6 hours .The presoaking enhances the rate of uptake of the mutagen through increase in cell permeability and also initiates metabolism in the seeds for treatment. Such presoaked seeds were later immersed in the mutagenic solution for 5hours with regular shaking. Seeds soaked in distilled water for 12 hours served as control. The different concentrations used for chemical mutagenic treatment were 0.05%, 0.10%, 0.15% for EMS and 0.010%, 0.015%, 0.020% for SA, respectively. Immediately after the completion of treatment, the seeds were washed thoroughly under running tap water to leach out residual chemical. Later on they were subjected to post-soaking in distilled water for one hour. Seeds of each treatment were sown in the field following randomized block design (RBD) with three replications along with control for raising the M_1 generation. The seeds were sown at a distance of 90 cm between the plants and 90 cm between the rows. The seeds of the M_1 plants were collected plant wise and again sown in the field in next season to raise the M_2 generation on plant to row basis and similarly those of M_2 generation were used to raise M_3 generation. A critical screening of the M_2 generation was

Corresponding author: Sangle, S. M.
Department of Botany, Dada Patil Mahavidhyalaya, Karjat, Ahmednagar-414402(M.S.)

carried out and data was subjected to estimate the various variability parameters following standard statistical procedure.

RESULTS AND DISCUSSION

Different types of viable mutants were observed in M_2 generation of pigeon pea. A wide spectrum of viable mutants with varying morphological traits was observed in M_2 generation of both the varieties of pigeon pea. The various types of viable mutants comprised high yielding, tall, dwarf, branched, early flowering, early maturing, light green pod, small pod, two seeded pod, five seeded pod types.

Frequency of viable mutants: All the concentrations of the mutagens used succeeded in inducing the different types of viable mutants (Tables1-2).The frequency of viable mutants revealed an increasing trend with gradual increase in concentration/dose of all the mutagens in both the varieties of pigeon pea. The frequency of viable mutants showed the highest values at 0.05% (EMS), 0.020% (SA) and 10kR (Gamma ray) treatments in pigeon pea except BSMR 853 variety where the highest value was 9.09% at 05 kR dose of Gamma rays. The frequency of viable mutants ranged from 3.17% to 5.97% in EMS, 4.10% to 7.04% in SA, 2.98% to 9.45% in Gamma ray and 3.33% to 4.47% in EMS, 4.83% to 13.23% in SA and 6.34% to 9.09% in Gamma ray treatments in BDN 708 and BSMR 853 varieties, respectively.

Data of the spectrum and relative percentage of viable mutants scored in M_2 generation shown in tables 1 and 2 have revealed a random trend with increase in concentration (%)/dose of all the mutagens in both the varieties of pigeon pea. High yielding mutant which is one of the productive mutants has shown highest relative percentage (33.32% and 25%) after 05 kR Gamma ray treatment and SA treatment (0.015%) in BDN 708, while 33.33% and 22.22% relative percentage after treatment of 0.010% SA and 0.020% SA, respectively in BSMR 853 variety could be noted. In BDN 708 tall mutant showed highest relative percentage (40%) at 0.020% SA treatment. The relative percentage BSMR 853 variety at 0.015% SA treatment also showed (40%). For dwarf mutant, relative percentage was found highest after Gamma ray 15kR (50.0%) and 0.10% EMS treatment in BDN 708 while in BSMR 853 variety the same value was noted (50.00%) after 0.15% EMS treatment. Early flowering mutant showed highest relative percentage 33.32% after SA treatment (0.010%) and 40.00% after SA treatment (0.015%) in the two varieties, respectively. Gamma ray treatment in BSMR 853 variety showed highest relative percentage 25.00% and 19.95%, respectively, for small pod mutant. Branched mutants showed highest values of 33.32 at 05 kR dose in BDN 708 and 25.00% at 10 kR dose of Gamma rays in variety BSMR 853. The details of morphological characters of the viable mutants scored in M_3 generation and description shown in Tables 3 and 4.

Viable mutation

Wide ranges of viable mutants were observed in M_2 and M_3 generations of both the varieties of pigeon pea. Positive correlation between frequency of viable mutants and concentrations were observed in SA treatments of both the varieties. Highest frequency could be observed at 10kR dose and 05kR dose after treatment of Gamma rays in variety BDN 708 and in variety BSMR 853 of pigeon pea, respectively. The spectra of viable mutations differed in different mutagenic treatments and also from one variety to another. The mutation frequency was random for different characters. In present work branched, tall, dwarf, dark black pod, small pod, early flowering, early maturing, two seeded, three seeded and high yielding mutants were found to be more pronounced. Many researchers reported induction of viable mutants in different plant systems after physical and chemical mutagenic treatments. Such workers comprise, Ehrenberg (1955), Kawai *et al.* (1961), Goud (1967), Gregory (1968), Blixt (1972), Joshua *et al.* (1972), Thakare *et al.* (1973), Choudhary (1974), Thakare and Pawar (1990), Kashid (2004) and Khadke (2005). The mutants screened were associated with various morphological changes in characters like days to flowering, days to maturity, plant height and number of pods per plant. Mahala *et al.* (1990) found that mutagenesis could widen variability in both positive and negative directions which results in sufficient variability in treated population that could be utilized for selection of early or late flowering plants. Malik *et al.* (1995) reported primary and secondary branches in rapeseed treated with Gamma rays. Use of induced mutation for obtaining early maturing cultivars has been a frequent breeding objective (Micke, 1979). Jana (1963) and Basu (1966) explained that early maturity may be due to physiological changes caused by irradiation and increased production of flowering hormone. Variation in maturity time following treatment with mutagenic agents has been reported in various other crops by Basu (1966), Pawar *et al.,* (1979), Kak and Kohl (1980) and Sengupta and Datta (2004) . Genter and Brown (1941) and Down and Anderson (1956), reported that the change in habit is the most common observation in many mutagenic studies. Irradiation may also be the cause of alteration in the plant habit.

In present study tall mutant has been obtained in both the varieties of pigeon pea. Tallness is fundamentally due to an initial increase in internode length, sometimes accompanied by an increase in internode number (Jana 1963). Increased length of cells and their number per unit area also contribute to tallness (Ehrenberg *et al.,* 1961, Miura *et al.,* 1974). Dwarf mutants are reported to be controlled by a single recessive gene (Moh and Alan 1964). Dwarf mutants with determinate growth habit in pigeon pea could be observed and have shown appreciable decrease in height in M_2 and M_3 generations. Dwarf mutants have been observed by workers like Down and Anderson (1956), Kothekar (1989), Kothekar and Kothekar (1992) in different crop plants. Athwal *et al.* (1970) created variability in plant height in chickpea through gamma radiation. In present investigation mutagens have shown effect on the plant height. The result indicated that the mutagen could cause both positive and negative genetic variability in plant height. High yielding is one of the agro-economically important characters. According to Adams (1974) the high yielding mutants have been related to the high number of pods per plant, which seems to contribute more to yield than the other seed yield components. Rubbeai (1982) reported in chickpea various mutants like early maturing, branched, tall, dwarf and high yielding types.

Table 1. Effect of mutagens on the spectrum and relative percentage of viable mutants in M_2 generation of pigeon pea variety BDN 708

Mutagen	Concentration (%) / Dose	Frequency of viable mutants	Spectrum and relative percentage of viable mutant										
			High yielding	Tall	Dwarf	Branched	Early Flowering	Early maturing	Light green pod	Dark black pod	*Xantha*	Small compact leaves	Erect and high yielding
EMS	0.05	5.97	--	--	--	--	--	24.99	24.99	24.99	--	24.99	--
	0.10	3.17	--	--	50.00	--	--	--	--	--	--	50.00	--
	0.15	5.79	--	--	--	--	--	--	24.99	50.00	--	--	24.99
SA	0.010	4.10	--	--	--	--	33.32	--	--	33.32	33.32	--	--
	0.015	5.54	25.00	--	25.00	--	--	--	--	25.00	--	--	25.00
	0.020	7.04	--	40.00	--	20.00	20.00	--	--	20.00	--	--	--
Gamma rays	05 kR	4.16	33.32	33.32	--	33.32	--	--	--	--	--	--	--
	10 kR	9.45	--	--	--	--	--	24.99	24.99	24.99	--	24.99	--
	15 kR	2.98	--	--	50.00	--	--	--	--	--	--	50.00	--

Table 2. Effect of mutagens on the spectrum and relative percentage of viable mutants in M_2 generation of pigeon pea variety BSMR 853

Mutagen	Concentration(%) / Dose	Frequency of viable mutants	Spectrum and relative percentage of viable mutant											
			High yielding	Tall	Dwarf	Branched	Early Flowering	Early maturing	*Xantha*	2-Seeded mutant	3-Seeded mutant	5-Seeded mutant	Reddish pod	Small pod
EMS	0.05	4.47	--	--	33.33	--	--	33.33	--	--	--	--	33.33	--
	0.10	4.28	--	--	33.18	--	--	--	--	--	--	33.18	33.18	--
	0.15	3.33	--	--	50.00	--	--	50.00	--	--	--	--	--	--
SA	0.010	4.83	33.33	--	--	--	33.33	--	33.33	--	--	--	--	--
	0.015	7.81	--	40.00	--	--	40.00	--	--	19.99	--	--	--	--
	0.020	13.23	22.22	11.11	--	--	--	--	11.11	--	11.11	11.11	22.22	11.11
Gamma rays	05 kR	9.09	--	--	--	16.67	--	--	--	16.67	33.33	16.67	16.67	--
	10 kR	6.34	--	--	--	25.00	--	50.00	--	--	--	--	--	25.00
	15 kR	8.47	--	--	19.95	19.95	--	--	--	--	--	--	40.00	19.95

Table 3. Performance of viable mutants with respect to quantitative characters in M_3 generation of pigeon pea variety BDN 708

Characters	Control	High yielding	Tall	Dwarf	Branched	Early Flowering	Early maturing	Light green pod	Dark black pod	*Xantha*	Small compact leaves	Erect and high yielding
Plant Height (cm)	231.33	221.00	241.33	174.33	193.66	211.33	229.67	219.33	219.66	206.00	260.34	222.33
No. of primary branches	23.87	23.66	21.67	16.66	25.33	21.00	21.34	19.00	17.33	19.34	19.66	22.67
Total no. of pods per plant	349.23	591.36	553.30	311.00	324.60	439.60	553.30	198.66	344.34	311.67	328.00	516.67
Days to 1st flowering	116.80	113.33	118.66	114.67	115.34	102.33	109.00	117.66	111.34	114.00	115.67	114.34
Days to pod maturity	169.07	167.00	163.33	169.34	166.66	162.00	158.33	162.34	165.67	164.33	164.00	167.34
Seeds per pod	101.70	123.34	106.00	95.33	105.34	121.34	120.33	106.66	107.67	85.34	115.00	101.00
Weight of 100 seeds(gm)	11.84	11.31	10.82	11.59	12.17	10.28	11.67	10.63	13.07	10.66	09.66	10.80

Table 4. Performance of viable mutants with respect to quantitative characters in M_3 generation of pigeonpea variety BSMR 853

Characters	Control	High yielding	Tall	Dwarf	Branched	Early Flowering	Early maturing	*Xantha*	2-Seeded mutant	3-Seeded mutant	5-Seeded mutant	Reddish pod	Small pod
Plant Height (cm)	197.87	209.33	214.34	148.00	200.66	204.66	174.67	202.67	196.00	201.66	202.00	205.66	206.34
No. of primary branches	21.43	27.00	18.33	16.34	28.67	22.67	14.66	20.66	21.00	25.00	22.34	21.33	27.66
Total no. of pods per plant	415.43	714.34	361.00	208.67	267.34	494.00	225.34	390.33	373.66	660.00	510.00	329.34	548.34
Days to 1st flowering	122.80	117.66	119.34	117.66	115.60	108.66	111.00	118.00	119.67	118.66	118.00	111.34	119.67
Days to pod maturity	181.80	173.00	171.67	175.33	173.34	161.33	158.66	171.34	173.67	170.34	171.66	174.67	179.66
Seeds per pod	100.63	96.00	106.33	77.00	118.34	114.33	98.34	96.33	97.64	102.66	105.66	108.67	111.34
Weight of 100 seeds(gm)	11.31	11.56	11.77	11.97	10.57	08.98	10.90	11.56	11.25	09.34	13.07	09.63	09.23

Different types of pod mutants were observed in present study. Two seeded, three seeded, five seeded mutants could be observed in variety BSMR 853 and dark black pod, light green coloured pod mutant were found in variety BDN 708 of pigeon pea. The variations in pod size like flat pod, long pod characters have been recorded by Singh and Agarwal (1986) in different plants systems. Compact leaves mutant was recorded in variety BDN 708.Various leaf mutants were reported by different workers like, Kellenberger (1952) in pea, Dnyansagar and Kothekar (1983) in *Solanum nigrum*, Satpute (1994) in safflower. The high yielding, two seeded mutants, dwarf, tall, dark black pod, small pod early flowering and branched are the promising mutants for further improvement of pigeon pea and there is scope for utilizing these characters for developing an improved variety of pigeon pea.

Acknowledgement

The author expresses his sincere thanks to Dr. V.S. Kothekar (Retired - Professor and Head, Department of Botany, B. A. M. University, Aurangabad) for guidance and constant encouragement all through the research work.

REFERENCES

Adams M.W. 1974. Plant architecture and physiological efficiency in the field beans and other food legumes in Latin America. CIAT. Cali, Colombia Series, Seminar 2E, pp.266-278.

Athwal D.S., Bhalla S.K. Sandhu S.S. and Brar H.S. 1970. A fertile dwarf and three other mutants in *Cicer*. *Indian J. Genet. Pl.Breed*., 30: 261-266.

Basu R.K. 1966. The induction of early flowering mutants in *Corchorus olitorius* L. Rad Bot 6: 39-47.

Blixt S. 1972. Mutation genetics in *Pisum, Agric*, Hort. Genet, 21:178-216.

Chaudhary U.S. 1974. Cytogenetic studies in *Trigonella foenum-graeum* Linn. Ph.D. Thesis, University of Bombay.

Dnyansagar V. R. and Kothekar V. S. 1983. Gamma rays induced morphological mutants in diploid *Solanum nigrum* L. Proc. Seminar: *Current approaches in cytogenetics*, Patna, 189-195.

Down E. F. and Anderson A. L. 1956. Agronomic use of x-ray induced mutants. *Science*, 124: 223-224.

Ehrenberg L. 1955. Studies on the mechanism of action of ionizing radiation in plants seeds. Sevensk Kem. *Tidsharar,* 67:207-224

Ehrenberg L., Gustafsson A. and Lundquist V. 1961. Viable mutants induced in barley by ionizing radiation and chemical mutagenesis. *Hereditas,* 47:243-252.

Genter C. F. and Brown H. M. 1941. X-ray studies on the field bean. *J. Heredity*, 32: 39-44.

Goud J.V. 1967. Induced mutations in breeding wheat. *Indian J Genet,* 27:40-55.

Gregory W.C. 1968. A radiation breeding experiment with peanuts *Rad. Bot*., 8:81-147.

Jana M.K. 1963. X- ray induced mutations of *Phaseolus mungo* L. II. Chlorophyll mutation *Caryologia*, 16: 685-692.

Joshua D.C., Rao C. and Gottschalk W. 1972. Evolution of leaf shape in jute. *Ind. J. Genet*., 32:392-399.

Kak S.N. and Kaul B.L. 1980. Radiation induced useful mutants of Japanese mint (*Mentha arvensis*) Z. Pflanzenzuchtung 85: 170-174.

Kashid N.G. 2004. Genetic improvement of okra through mutation breeding. Ph.D. Thesis Dr. B.A. Marathwada University, Aurangabad. MS. India.

Kawai T., Sato M. and Masima J. 1961. Short culm mutations in rice induced by p32- proc. Symp. "Effect of ionizing radiations on seeds", IAEA, Vienna: 565-573.

Kellenberger S. 1952. Inheritance and linkage data of some characters in pea (*Pisum sativum*). *J. Genet.* 51: 41-46.

Khadke S. G. 2005. Genetic improvement of moth bean (*Vigna aconitifolia* (Jacq). Marechal) through mutation breeding, Ph.D. thesis, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India.

Kothekar A.V. and Kothekar V. S. 1992. Promising mutants in moth bean. *Marathwada University J. Sci.* 19: 1-2.

Kothekar V. S. 1989. Differential radiation sensitivity in moth bean. *Curr. Sci*. 58(13): 758-760.

Mahala S.V.S., Mor B. R. and Yadav J.S. 1990. Induced genetic variability for oil content in mustard. (*Brassica juncea* L. Czern and Coss). Oil Crops Newsletter.IDRC, Ottawa, Canada. No7: 13-15.

Malik V., Singh H. and Singh D. 1995. Gene action of seed yield and other desirable characters in rape seed. Annals of Biology (Ludhiana) 11 (1-2): 94-97.

Micke A. 1979. Use of mutation induction to alter the ontogenic pattern of crop plants.Gamma Field Symposia No. 18: 23.Institute of Radiation breeding. Ohniya, Ibanraki-ken, Japan.

Miura K., Hashimoto T. and Yam Aguchi H. 1974. Effect of Gamma radiation on cell elongation and auxin level in *Avena* coleoptiles. *Rad. Bot.* 14: 207-215.

Moh C.C. and Alan J.J. 1964. Bean mutants induced by ionizing radiation. I. Dwarf mutant. Turrailba 14: 82-84.

Pawar S.E., Thakare R.G. and Joshua D.C. 1979. Early maturing bold seeded mutant in pigeonpea [*Cajanus cajan* (L.) Millsp.]; *Curr* Sci., 48(14): 643-645.

Rubbeai-Al 1982. Radiation–induced mutations in *Phaseolus vulgaris* L. Rev. Brasil. Genet. (*Brazil. J.Genetics*.) Vol 3, pp 503-513.

Satpute R.A. 1994. Mutational studies in safflower (*Carthamus tinctorius* L.) Ph.D.Thesis, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad, MS, India.

Sengupta S. and Datta K. 2004. Induced protein rich late flowering and seed coat colour mutants in sesame (*Sesamum indicum* L.). *J.Cytol. Genet.,* 5 (NS):27-31.

Singh V. P. and Agrawal S. 1986. Induced high yielding mutants in cluster bean. *Ind. J. Agric. Sci.,* 56(10): 595-700.

Thakare R. G., Joshua D.C. and Rao N.S. 1973. Induced viable mutation in *Corchorus olitorius* L *Ind J. Genet* 33: 204-220.

Thakare R.G. and Pawar S.E. 1990. Radiation induced mutants for the improvement of urdbean, INS Newsletter 2: 18-19.

****