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RESEARCH ARTICLE

PHYSICAL AND CHEMICAL MUTAGENS INDUCED THE YIELD TRAITS OF BLACK GRAM (*Vigna mungo* L.)

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ABSTRACT

Induced mutagenesis used to investigate the different treatments of gamma irradiation viz., 20, 40, 60, 80 and 100kR and Ethyl Methane Sulphonate (EMS) viz., 5, 10, 15, 20 and 25mM on growth and yield parameters of black gram *Vigna mungo* var. VBN_1. Present study revealed that based the physical and chemical mutagenic sensitivity of black gram was compared to control as well as treated plants. In this investigation, all the quantitative characters and yield characters were stimulated from 20 to 60kR and 5 to 15mM of gamma rays and EMS the inhibition occurred more in 60kR and 15mM. Among these two mutagens results showed EMS (15mM) was found to be more effective and improved the yield characters compared to those of gamma rays treatment.

INTRODUCTION

Mutations are induced by physical and chemical mutagen in both seed and vegetatively propagated crops. The mutagenic treatments break the nuclear DNA, during the process of DNA replication. The changes can occur in cytoplasmic organelles and may result in chromosomal or genomic mutations that enable plant breeders to select useful mutants with flower colour, flower shape, disease resistance, early flowering types for crop improvement (Crino, 1994; Donini and Sonnino, 1998 and Jain and Maluszynski, 2004). The use of induced mutations over the past 50 years has played a major role in the development of superior crop varieties resulting tremendous economic impact on agriculture and food production that is currently valued in billions of dollars and millions of cultivated hectares (Kohanjain, 2010). Mutation breeding in crop plants is an effective tool especially in food crops as they have narrow genetic base. Mutagenesis has become popular over past decades because it is simple and inexpensive involving small/large scale. The frequency of induced mutations can be regulated and saturation can be readily achieved (Robbie *et al*. 2006). Mutation induction with radiation is a most frequently used method to develop direct mutant varieties, accounting for about 90% of obtained mutant varieties 64% from gamma – rays and 22% from x-rays (Jain, 2005). There are two types of radiation involved in induced mutagenesis viz., Ionizing radiation (x- rays, gamma rays, alpha, beta particles and neutrons) and non-ionizing radiation (UV). Among these, gamma radiation has provided a higher number of useful mutants (Predieri, 2001) and is still showing elevated potential for improving crop plants. Chemical agents can be useful as they provide high mutation rates mostly point mutation (Jain, 2005). Ethyl methane sulphonate (EMS) is a chemical mutagen of alkalyting group and has been commonly used in plant breeding because it can cause high frequency of gene mutation and low frequency of chromosome aberration (Van Harten, 1998).

Vigna mungo (L.) Hepper (Fabaceae), commonly known as Urd bean or black gram, is an important pulse crop of India. It has a major source of stored protein and minerals. Quantitative traits provide an estimate of genetic diversity and principal component of yield characters are improved successfully through induced mutation in black gram (Ghafoor *et al.,* 2001) Broad genetic base to augment and recreate wide genetic variability used to improved agronomic traits that the present study deals with the effects of gamma rays and EMS.

MATERIALS AND METHODS

Seeds of black gram (*Vigna mungo*) var.VBN_1 were treated with different doses of gamma radiation (20, 40, 60, 80 and 100kR) and Ethyl Methane Sulphonate (5, 10, 15, 20 and 25 mM). The seeds were irradiated at Sugar cane Breeding Institute at Coimbatore, Tamil Nadu, India. The gamma radiation was derived from ^{60}Cobalt source with a measured

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dose rate of 2.6 Kr/min. The chemical mutagen of EMS was obtained from HIMEDIA Laboratory limited, Mumbai, India which having a dosimetry /half life period is 30 hours with a molecular weight is 124.16 and density 1.20. For each treatment 200 seeds were treated with gamma irradiation and EMS. M_4 generation was raised from the M_3 generation in a randomized block design (RBD) with three replication used to determine the growth and yield characters. Data were analyzed using NPRC software package.

RESULTS AND DISCUSSION

Quantitative characters in M_4 generation

Table1 shows quantitative characters of control as well as treated plants. A significant variation in mean value of plant height and root length was observed in the treatments of gamma rays and EMS in M_4 generation. Maximum increase in plant height (52.29, 53.27) and Root length (13.15, 17.50) has been observed in 60kR and 15mM of gamma rays and EMS respectively. The hypothetic origin of these stimulations by irradiation and EMS treatments was due to in cell division rates as well as an activation of growth hormone, e.g., Auxin (Zaka *et al.,* 2004 and Gunckel and Sparrow 1961). In case of number of branches and leaves maximum at 15mM of EMS (4.80 and 52.54) compared to control and other concentration of EMS and gamma rays treatment. Similarly, plant height and number of primary branches per plant showed significant improvement over the control in M_3 generation of chick pea with effect of gamma rays and EMS than control (Wani and Anis, 2001).The stimulatory effects were showed leaf length and breadth at 60kR (12.65 and 7.90) and 15mM (13.61 and 6.69) of physical and chemical mutagens.

early maturity mutant. It has taken minimum days to fruiting and maturity of plants. Both the mutagens at higher concentration caused a delayed flowering and fruiting might be due to their inhibitory effect. Early flowering was also reported by Dhakshanamurthy *et al.* (2010) in *Jatropha curcus* and wani and Khan (2006) in mungbean found early ripening mutants and seed production. Girhe and Choudhary (2002) recorded early flowering and high yield in M_3 generation of gamma rays in *Lathyrus.* These findings showed lower concentrations that physical and mutagens can change flowering of days and fruit maturity.

Table 2 shows Significant variation was observed at $p>0.05$ level in the maximum number of clusters per plant (15.60), pods per plant (60.15), and number of seeds per pod (9.53), 100 seed weight (5.83) and seed yield (12.33) per plant recorded in 15mM of EMS when compared to that of control and other dose / concentrations of gamma rays and EMS. While minimum number of clusters per plant (11.66), pods per plant (15.00), and number of seeds per pod (6.90), 100 seed weight (3.32) and seed yield (6.80) per plant recorded in 80kR of Gamma rays. A high degree of correlation between number of pods per plant and number of fertile branches per plant was reported earlier by Khan and Siddiqui (1997) in mungbean and Kharkwal (2003) in chickpea. Rubaihayo (1976) obtained high yielding mutants and found significant genetic variability in yield and maturity in soybean plants, grown from seeds irradiated with gamma rays. Mutation breeding has played a productive role in sustainable agriculture (Larik and Jamro, 1993) as it is supplementary approach for crop improvement which increases unselected genetic variability for practical breeding application.

Table 1. Impact of Physical and chemical mutagenic treatment on quantitative characters in Black gram

Treatment	Plant height (cm)	No. of branches / plant	No. of leaves / plant	Leaf length (cm)	Leaf breadth (cm)	Root length plant (cm)	Days taken to first flowering
Control	45.13±6.03	3.87± 0.47	45.26 ±0.57	10.51 ±0.56	5.06 ±0.58	14.49 ±0.54	31.92 ±2.16
Gamma rays (kR)							
40	45.88±4.06	3.32 ±0.79	46.27 ±0.58	10.71 ±0.37	6.91 ±2.55	11.61 ± 0.58	31.86 ±2.09
60	52.29 ± 3.85	4.30 ±0.56	47.49 ±0.55	11.34 ±2.36	7.81 ±0.59	12.05 ±0.59	29.47 ±2.57
80	45.64 ±3.95	2.75 ±0.74	50.59 ±0.65	12.65 ±0.60	7.90 ±1.58	13.15 ±0.62	33.60 ±2.70
EMS (mM)							
10	49.76 ± 4.05	3.66 ±0.43	46.57 ±0.59	10.30 ±1.60	5.21 ±0.59	15.00 ± 0.59	30.23 ±1.79
15	53.27 ± 1.66	4.80 ±0.34	48.33 ±0.61	10.52 ±0.62	6.20 ±1.61	16.75 ±0.60	28.29 ±2.00
20	35.76 ± 3.77	3.46 ±0.48	52.54 ±0.55	13.61 ±1.92	6.69 ±0.58	17.50 ±0.59	32.78 ±1.90

*Mean ± SE

Table 2. Impact of Physical and chemical mutagenic treatment on Yield characters in Black gram

Treatment	Cluster / plant	Pods / plant	Seeds / pod	100 seed weight (g)	Seed yield / plant (g)
Control	11.00 ± 0.60	35.45 ± 0.59	7.03 ± 0.56	3.53 ± 0.49	6.12 ± 0.17
Gamma rays (kR)					
40	15.60± 2.50	36.12 ± 3.79	7.40 ± 1.92	4.32 ± 1.10	7.40 ± 0.63
60	16.22 ± 1.57	43.40 ± 1.87	8.95 ± 1.97	4.61 ± 0.52	10.26 ± 0.76
80	11.66 ± 3.31	30.15 ± 4.63	6.90 ± 1.07	3.32 ± 0.15	6.80 ± 0.63
EMS (M)					
10	15.30 ± 3.61	38.37 ± 2.28	7.93 ± 1.59	4.70 ± 0.38	8.66 ± 0.52
15	17.20 ± 2.38	45.65 ± 3.47	9.53 ± 1.27	5.83 ± 0.43	12.33 ± 0.63
20	14.55 ± 1.10	31.39 ± 2.53	8.20 ± 1.19	4.27 ± 0.19	7.80 ± 0.83

*Mean ± SE

Days to first flowering was taken to minimum days mean values (29.47) in LD_{50} concentration of 60kR and 15mM (28.29) of physical and chemical mutagens. It's due to earned

Chemical mutagens therefore, require more care in their application when compared with physical mutagens (Liharska *et al.,* 1997 and Vizir *et al.,* 1994). Based on these findings

EMS promoting effects of lower doses in 15mM and improved the yield characters compared higher dose concentration of physical and chemical mutagens. There are several reports in other legume crops such as soybean (Cooper *et al* 2004) and mung bean (Santhu *et al.,* 2003). Manohar Rao and Tummala (1984) observed a wide range of viable mutants, with alternation in plant height; stem, branch, leaf, flower, pod and semi dwarf, and dwarf were frequently observed in pigeon pea. In treating rice cultivars with gamma rays and EMS several dwarf and early flowering/maturity in M_2 plants and blast resistant in M_3 plants, observed by Bansal and Katoch (1991).

Conclusion

In the present study revealed all growth and yield traits were significantly high at 60kR of gamma rays and 15mM of EMS. Among these two mutagens used, particularly EMS (15mM) was found to be more effective and more yield were recorded as compared to control and gamma ray treatments. Number of useful mutant's viz., more number of cluster and pods were identified, especially early maturity mutant used induced the yield characters and have taken to minimum days at maturity. In recent years, mutation breeding has been gaining ground for inducing genetic changes and creation of new genetic resources. So, it is concluded that this traits may be considered as the selection criteria for the improvement of yield.

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